1940

The University of Tennessee Agricultural Experiment Station. Fifty-Third Annual Report, 1940

University of Tennessee Agricultural Experiment Station

THE UNIVERSITY OF TENNESSEE
AGRICULTURAL EXPERIMENT STATION

FIFTY-THIRD ANNUAL REPORT
1940

Five yearling jacks, all sired by U. T. Logan.

KNOXVILLE, TENNESSEE

LETTER OF TRANSMITTAL

Knoxville, Tennessee, January 1, 1941

To His Excellency, Prentice Cooper, Governor of Tennessee.

Sir: I have the honor to transmit herewith, on behalf of the Board of Trustees of The University of Tennessee, a report of the work and expenditures of the Agricultural Experiment Station for the year 1940. This report is submitted in accordance with the law requiring that the Board having direction of the Experiment Station shall annually submit to the Governor of the State a report of its operations and expenses.

Very respectfully,

JAMES D. HOSKINS, President.

THE UNIVERSITY OF TENNESSEE

AGRICULTURAL EXPERIMENT STATION

In account with

The United States Appropriations under the Hatch, Adams, Purnell, and Bankhead-Jones Acts, and Offset to Bankhead-Jones Fund, 1939-40.

	Federal Funds				Bankhead-Jones Offset
	Hatch	Adams	Purnell	Bankhead-Jones	
Dr.					
Receipts from U. S. Treasurer	$15,000.00	$15,000.00	$60,000.00	$74,783.88	
Receipts from other sources					$74,783.88
Cr.					
Personal services	11,375.25	13,725.33	54,193.77	55,236.13	42,423.76
Supplies and materials	663.66	480.90	2,143.50	5,055.21	9,365.83
Communication service	491.68	1.49	13.24	202.79	588.41
Travel expenses	110.06	214.26	667.54	1,820.49	1,684.89
Transportation of things	94.84	11.82	141.27	621.09	646.17
Publications	1,514.21				409.98
Heat, light, water, power	48.32	127.72	333.02	302.12	1,168.16
Contingent expenses	20.62		1.50	6.71	92.79
Equipment	656.41	386.20	2,333.64	7,490.83	14,079.88
Land		44.50		2,328.75	833.00
Structures and nonstructural improvements	24.95	7.78	172.52	1,719.76	3,491.01
Total	$15,000.00	$15,000.00	$60,000.00	$74,783.88	$74,783.88

FIFTY-THIRD ANNUAL REPORT OF THE AGRICULTURAL EXPERIMENT STATION OF THE UNIVERSITY OF TENNESSEE, FOR 1940

ADDITIONAL LAND FOR STATION WORK

Certain kinds of experiment station work require farm-size acreages for practical trials. Experiments in cattle grazing belong in this class. The substation at Greeneville was originally intended for tobacco investigations, but the combination of livestock farming and tobacco as a cash crop is a very practical one, especially as tobacco is subject to a limited acreage and requires farmyard manure in order to get the highest yields and best quality. Originally the Greeneville Station, as purchased from F. C. Wilhoit, contained only 149 acres. An additional area of 14 acres was purchased to provide more suitable land for plot experiments. Later an adjoining farm of 163 acres was purchased for a grazing and broadcast-farming project. In 1940, a 54-acre tract was purchased for the livestock work. The total at this time, therefore, is 380 acres, which is a moderate amount for the objects in view.

The Middle Tennessee Station has 652 acres by the original purchase. In 1936 an adjoining farm of 129 acres was bought for a special Bankhead-Jones project on jack-stock. In 1940, a much needed 23-acre tract was added to the jack-stock farm. The total at Columbia is 804 acres, which appears to be ample for Station purposes at this time.

The West Tennessee Station has about 210 acres, an insufficient amount to meet the requirements for so large and important a section of the State. About two acres at the Memphis highway entrance to the farm were purchased in 1940 to afford control of both sides of the farm road. It is hoped that a large additional acreage for experimental use can be obtained at an early date. Such a purchase would meet with the hearty approval of the citizens of Jackson, as well as of farmers throughout West Tennessee. This Station is considered a credit to the State and, if possible, should receive increased support.

AGRONOMY

CROP IMPROVEMENT

N. I. Hancock

COTTON

The season of 1940 was a peculiar one in its effect on lint percentage of cotton varieties. Lint percentage was lower than common in all tests, as well as under general farm conditions. Lint index, or amount of lint around each seed, remained normal, but the seed carried more weight, probably because of high humidity while the bolls were maturing.

The variety tests showed that inbred, or selfed, lines of cotton do not lose their vigor as do corn and many other open-pollinated crops. In pounds of seed cotton, Tennessee 15-612 ranked fourth at Jackson and second at Tiptonville, among the 10 varieties tested. Tennessee 8-66 ranked third in the new-strains test at Jackson. Both of these lines were considerably earlier than all other varieties. They are selections out of Stoneville 2 and have been selfed for 6 years; only selfed seed of these lines were used in tests.

Stoneville 2B, Deltapine 12, Coker 200-1, and Washington continue as the recommended varieties for Tennessee. Coker 200-1 is earlier than the other 3 varieties. It has higher lint turnout than Stoneville 2B or Washington, but smaller bolls. About 75 bolls of Coker 200-1 will make one pound of seed cotton, whereas Deltapine requires 85 bolls.

Of the 800 inbred lines, 50 have been retained for further tests in 1941. Fibrograph length determinations on these inbred lines proved that they were more uniform than the open-pollinated varieties.

OATS

It will be recalled that crosses of the new Tennessee winter oats—Fulwin, Tennex, and Tennessee 092—were made with Victoria and Bond. These last two varieties are very resistant to all forms of smut and rust but have the spring type of growth, so that it has been necessary to obtain winter-hardy selections from the crosses. These selections now are in the fourth generation and offer some promise of providing disease-resistant strains which are also winter-hardy.

BARLEY

The smooth-awn strain of barley, B5-9, was placed in the variety tests at 3 stations. A comparison of its yield with that of No. 52 bearded, the standard variety grown in Tennessee, is given in table 1.

A number of other smooth-awn as well as hooded lines of barley are being tested. All are winter-hardy, and need to be tested only for

yielding capacity. Polders, a bearded barley, has been found to excel others in its non-susceptibility to lodging, and it is being used in crosses on other varieties.

TABLE 1—*Yields of barley in bushels per acre.*

Variety	Knoxville	Columbia	Jackson
	Bushels	Bushels	Bushels
Smooth Awn B5-9	61.7	54.6	70.5
No. 52 bearded	57.3	56.3	67.2

Circular No. 67, "Poor Germination of Mechanically Dehulled Oats," was published in May. It emphasizes the importance of careful threshing to avoid dehulling. Dehulled oats, commonly called "groats," germinate very poorly.

IMPROVEMENT OF GRASSES FOR PASTURE

J. K. Underwood

Further improvement has been achieved in several English ryegrass strains by means of straight-line selection from selfed plants. It is hoped that after another year or two of breeding, these strains will be ready for multiplication.

Selections were made from acclimated wild orchard-grass plants which showed good pasture types and hay types. Longevity of the various selections will be studied and further selections made accordingly. These will be selfed.

Tall oatgrass plantings this year have shown greater vigor than the original planting, which suffered a 50-percent loss from disease. This does not prove that the selections from the survivors are resistant to the disease known as *Sclerotium rolfsii*; the apparent immunity may be due to absence of the fungus. These selections will be studied primarily for longevity, then pasture and hay types will be isolated.

Harding-grass plants during the summer of 1940 were hit by a severe red-spider infestation. Upon careful inspection it was discovered that every plant was badly infested, except one. This one plant was selected merely for red-spider resistance. It was observed to have very much coarser foliage than plants showing infestation. Selections of other plants were not made until after new growth was well established. Red-spider did not reappear, probably because of the cooler fall weather. These selections were selfed, seed were sown early in the fall, and plants set out in November.

About one acre of ground has been sown to the biennial strain of rescue grass for multiplication. This grass is very palatable, especially during winter and spring, and should be worked in with short pasture rotations. Since it volunteers readily, it could be used also in a permanent-pasture planting.

At the Knoxville Station, 137 plots of various species of grass were sown. Also 101 species were sent to the Greeneville Tobacco Station for planting in small trial plots. These trial plantings were in cooperation with the U. S. Department of Agriculture, Soil Conservation Service. A great number of the plantings failed for lack of acclimatization. Among the most promising annuals for grazing or hay are *Panicum ramosum*, *P. texanum*, and Browntop millet (*Panicum fasciculatum* var. *reticulatum*). One of the best perennials is *Andropogon ischaemum*. Other grasses deserving consideration are Buffalo grass (*Buchloe dactyloides*), Blue grama (*Bouteloua gracilis*), *Panicum antidotale*, *Paspalum malacophyllum*, *P. pubiflorum*, *P. ciliatifolium*, *P. pubescens*. Grazing and palatability tests have not been made.

A number of successful crosses of *Lolium perenne* x *Agropyron pseudorepens* and *L. multiflorum* x *Agropyron pseudorepens*, with the latter as the female parent in each case, were made again in 1940. These are weak, slow-growing plants. They were treated when small seedlings with 0.1-percent colchicine in the hope that the chromosome number could be doubled to make the plants fertile, since those crosses are intergeneric and would in all probability be sterile. The plants will not mature until the spring of 1941. The young seedlings were treated with colchicine because the treatment of the seed failed last year. From all appearances the seedlings will not mature.

CORN HYBRID PERFORMANCE TESTS

L. S. Mayer

For many years the Agricultural Experiment Station, through its Agronomy Department, in cooperation with the Division of Cereal Crops and Diseases, Bureau of Plant Industry, U. S. Department of Agriculture, tested numerous strains and varieties of corn both from individual farmers and from commercial producers. With the introduction of corn hybrids and an ever-increasing sales pressure from Corn-Belt producers upon the farmers of the State, it has become necessary to expand the testing facilities.

In the spring of 1940, O. W. Dynes, Associate Agronomist of the Station, selected 2 test plots in each of the three grand divisions of

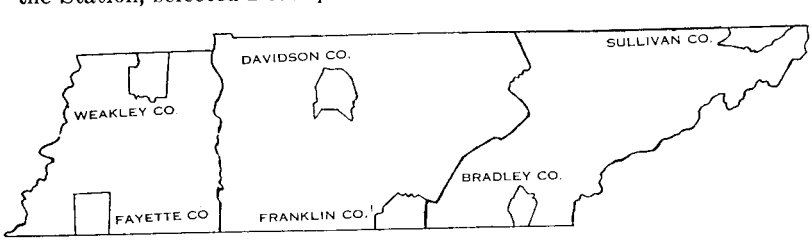

Fig. 1—Location of fields used in 1940 corn-performance tests.

the State, making 6 fields in all. One of these was located in the northern and one in the southern half of each division. Soil types as representative as possible were selected. Each plot was 2 rows wide and 25 plants long. The field design was a randomized block of 5 replications. To cover at least part of the expense involved in this testing, fees were charged and the entry list was thrown open to all breeders and producers. One year's trial has shown that the fees were much too low. Travel expenses for planting, thinning, and harvesting were only partially met, and it was evident that the charges would have to be increased for 1941. Professor Dynes' untimely death, in May, necessitated the writer's assuming responsibility for conducting the tests.

The data presented give only the yields, in bushels of air-dry shelled corn per acre, for all entries in each field. Percentages of barren plants, upright plants, and prolific plants (bearing 2 or more ears) were obtained.

It has been the custom at the Experiment Station to use the open-pollinated Neal Paymaster as a check for corn variety trials. Seed from the originator was used during his lifetime, and since his death the improved strain developed at the Station has been used as foundation stock Neal Paymaster. This variety, over a long period of testing, has proved to be the best-yielding white dent corn, having a wide range of adaptability and a high degree of prolificacy. It is the variety with which any other variety or hybrid must compete when grown in this State. Other varieties of white dent corn are Jellicorse, which does well on rich land, and Thompson Prolific, which is an excellent short-season variety, adapted to higher elevations and the southwestern section of the State.

The summary table shows all the entries in the tests under the fields in which they were entered; the yields and rank in each field; and, where entries occurred in all fields, the average yields and ranks for the 6 tests. Tennessee Hybrid 15 gave an average yield of 64.6 bushels; Tennessee Hybrid 10, 58.8 bushels; Funk Hybrid G125, 58.5 bushels; and Foundation Neal Paymaster, 57.5 bushels. It will take more than a one-year test to bring out the relative merits of the various hybrids offered for sale in Tennessee and any specific regional adaptation they may have. Moreover, the 2 top-ranking hybrids are Tennessee hybrids, which were top-ranking also in state tests in 1939 and have shown a wide field of usefulness in neighboring states.

This opportunity is taken to express appreciation to the following gentlemen for their splendid cooperation in making these tests possible: Prof. C. C. Cravens, Martin; Mr. H. A. Armour, Somerville; Mr. Roscoe Drake, Goodlettsville; Mr. W. L. Arnold, Winchester; Mr. R. P. Carmack, Bristol; Mr. James Campbell, Cleveland; and to these county agricultural agents: C. O. Woody, T. L. Mays, E. H. Swingle, and G. C. Baker. Acknowledgment is also made to Mr. A. H. Fitzgerald, Junior Agronomist, for his assistance in the work.

TABLE 2—*Yield and rank of each corn entry in six test fields, and mean yields of those entries grown in all six fields.*

Variety	Field No. 1		Field No. 2		Field No. 3		Field No. 4		Field No. 5		Field No. 6		Av. 6 fields		No. of tests
	Yield	Rank	Yield	Rank	Yield	Rank	Yield	Rank	Yield	Rank	Yield	Rank	Yield	Rank	
Tennessee Hybrid 15	96.2	1	47.5	6	54.2	2	42.7	8	81.1	2	66.2	6	64.6	1	6
Tennessee Single Cross (10B x 13F)	84.1	2													
Funk Hybrid G46	80.2	3	48.0	4	38.0	26	36.0	19	68.9	10	59.4	11	55.1	6	6
Foundation Neal Paymaster	79.5	4	44.3	12	44.1	14	36.0	19	71.6	8	69.5	4	57.5	5	6
Funk Hybrid G135	79.2	5	38.5	27	47.5	6	43.5	6	76.6	4	60.2	10	57.6	4	6
Iowealth Hybrid 30A	79.0	6	39.8	24	44.4	13									
Iowealth Hybrid TX-3	78.5	7			43.3	16	40.2	12							
Tennessee Hybrid 10	78.4	8	40.7	22	42.1	18	46.5	4	71.8	7	73.6	2	58.8	2	6
Woods Hybrid Golden Prolific	76.8	9	42.1	19	35.1	28	36.4	18	69.2	9	58.7	13	53.0	12	6
National Hybrid 128	75.6	10			45.0	12									
Funk Hybrid G583W	74.6	11	45.3	10	41.2	21	37.3	15	64.5	15	56.1	15	53.2	11	6
Iowealth Hybrid 29K	74.0	12													
Funk Hybrid G588W	73.2	13	41.9	20	40.6	23	37.0	17	76.0	5	58.9	12	54.6	9	6
Pioneer Hybrid 332L.F.	72.8	14	41.3	21	46.0	10									
Funk Hybrid 1005	72.8	14			47.6	5			63.2	17					
Iowealth Hybrid TX-1	72.4	15	39.1	25			53.6	1			66.2	6			
Yellow Paymaster	72.3	16	47.2	7	43.4	15	44.8	5	67.2	13	55.3	17	55.0	7	6
Pioneer Hybrid 307 L.F.	71.7	17	41.9	21	40.8	22									
Iowealth Hybrid 28N	71.4	18	44.1	13	43.4	15	36.4	18	57.3	24	55.6	16	51.4	14	6
Gordon Prolific	70.9	19													
Funk Hybrid G125	70.7	20	50.7	2	42.0	19	50.8	2	68.6	11	68.2	5	58.5	3	6
National Hybrid 134D	70.4	21													
Iowealth Hybrid TX-2	69.2	22													
Pioneer Hybrid 313MR	68.8	23	36.9	30	48.1	4									
DeKalb Hybrid 816	68.1	24	37.2	29	46.9	7	31.0	20	61.7	19	54.6	18	48.9	16	6
DeKalb Hybrid 899	68.1	24	46.5	8	38.5	24	40.3	11	72.3	6	63.5	7	54.9	8	6
Funk Hybrid G90	68.0	25	42.9	17	44.1	14	37.2	16	63.3	16	60.7	9	52.7	13	6
Iowealth Hybrid 29A	65.3	26	43.6	15	46.2	9	40.8	9	64.7	14	62.4	8	53.8	10	6
National Hybrid 130D	63.6	27			45.4	11									
Woods White Prolific	59.3	28	33.9	32	38.2	25	30.4	21	60.8	21	53.2	19	46.0	17	6
Missouri Hybrid 8	58.8	29	40.0	23	42.2	17									
National Hybrid 136	58.6	30													
Funk Hybrid 840	57.3	31			41.6	20			53.8	25					
Yellow Thompson	57.0	32	45.1	11	29.6	30	40.7	10	67.4	12	56.8	14	49.4	15	6
Thompson Prolific	54.8	33	52.8	1	37.3	27	38.0	13	60.6	22	50.0	22	48.9	16	6

TABLE 2—*Concluded.*

Variety	Field No. 1		Field No. 2		Field No. 3		Field No. 4		Field No. 5		Field No. 6		Av. 6 fields		No. of tests
	Yield	Rank	Yield	Rank	Yield	Rank	Yield	Rank	Yield	Rank	Yield	Rank	Yield	Rank	
National Hybrid 135 White	53.8	34													
Southern Hybrid 301			50.5	3											
National Hybrid 132T-1			47.9	5											
L. P. Cook Hybrid 134TH			46.2	9											
L. P. Cook Hybrid 130D			43.9	14											
Southern Hybrid 325			43.2	16											
L. P. Cook Hybrid 129			42.9	17											
National Hybrid 134			42.3	18	46.4	8									
L. P. Cook Hybrid 128			41.3	21											
L. P. Cook Hybrid 135			41.3	21											
Southern Hybrid 312			39.0	26											
L. P. Cook Hybrid 131			37.5	28											
Jellicorse			35.9	31											
Southern Hybrid 302			31.5	33											
Southern Hybrid 303			30.6	34											
Tennessee Single Cross (7B x 13F)					58.9	1									
Tennessee Single Cross (13F x 7B)					54.1	3									
Martin Yellow Dent					34.9	29									
Tennessee Single Cross (10B x 14E)							49.3	3							
Tennessee Single Cross (10B x 83S)							42.8	7							
Tennessee Single Cross (10B x 49B)							37.4	14							
Looney Corn							23.5	22							
Tennessee Single Cross (28A x 10B)									83.4	1					
Tennessee Single Cross (10B x 28A)									77.4	3					
Golden Queen									62.0	18					
Iowealth Hybrid 25									61.4	20					
Myers' Jarvis Golden Prolific									59.5	23					
Tennessee Single Cross (105B x 10B)											75.8	1			
Tennessee Single Cross (10B x 105B)											69.8	3			
Iowealth Hybrid 30K											53.0	20			
Iowealth Hybrid 30P											52.3	21			
Moore Corn											49.3	23			

STATE SOIL SURVEY

W. O. Whittle

During the year 1940 the soil survey of 842,022 acres was completed, bringing the total up to 4,710,687 acres. Progress, while not quite so great as last year in number of acres covered, nevertheless is satisfactory for the reason that more detail information has been mapped, particularly as to erosion. The survey was completed in Rhea, Union, Claiborne, Grainger, and Hamblen Counties, and those parts of Campbell and Anderson lying within the Norris Area. It is nearing completion in Decatur, Knox, Benton, and Carter Counties. Some work has been done in Stewart County. Gilbertsville, Fort Loudoun, and Cherokee Areas are completed, and all field men will now be concentrated on county work.

Fourteen men supported mainly by the Tennessee Valley Authority are giving full-time service in the field, and for a part of the time three men from the Bureau of Plant Industry, U. S. Department of Agriculture, also were engaged in the work. Coloring has been completed on one map each of Cumberland, Humphreys, Roane, Lincoln, and Hamilton Counties, on two of Bedford, and one of the completed portion of Campbell County.

We now have samples of the principal soils from 12 counties, all of which have been analyzed for lime, phosphorus, and potash. The analyses, together with the statistical data being preserved, should be a very material guide toward a better knowledge of the characteristics of the soils in the State.

TRUCK-CROP EROSION PROJECT

N. D. Peacock

The truck-crop erosion study was continued during 1940 as a cooperative project. Mr. K. B. Sanders, of the General Chemistry Department, has tested and checked the accuracy of the sampling apparatus and has collected and tabulated all of the water-runoff and soil-loss data. This represents the major part of the work. Mr. A. L. Kennedy, of the Agricultural Engineering Department, has assisted, as heretofore, in the study and adjustments of the sampling apparatus.

There have been no major changes in the apparatus, but minor improvements have been made to increase the accuracy of the sampling. The shed roof was enlarged to provide a more adequate supply of water for the operation of the apparatus. The sampling devices were calibrated at intervals.

Following the 1939 season, the sod and cultivated strips were reversed, with the exception of plot No. 6, which was continued as a cultivated plot. The sod strips in plots 1, 2, and 3 were turned and used for cultivation during 1940. Strips previously in cultivation

were seeded to a clover-and-grass mixture and have been in sod. The same plan for all plots will be continued in 1941. Plot 4, which had been in sod, was turned and put into cultivation, while plot 5, previously cultivated, was seeded to a clover-and-grass mixture. This change afforded an opportunity to observe the effect on water run-off and soil loss produced by the turning under of a 2-year-old sod.

The cropping plan for the cultivated strips was the same as that practiced during the two previous seasons. The same fertilizer was used and the same cultural methods were followed. The spring crop was Irish Cobbler potatoes, planted March 18 and harvested July 15. The second crop was Green Mountain potatoes, planted August 10 and harvested November 12. The unusually dry fall prevented normal growth of the late-crop potatoes and resulted in an almost complete failure of that crop. The yields do not show any significant results related to the plot treatments.

The annual rainfall of 41.52 inches was less than normal. Run-off occurred during 25 rains, but was extremely serious during only 2 of those rains, April 4 and August 7. The total water run-off and soil losses were light, compared with those of 1938 and 1939. The light rainfall, no doubt, influenced the losses, but evidence is strong that the turning of the sod greatly reduced the water run-off and soil loss.

Comparison of plots 4 and 6, which were cultivated, is striking. Plot 4, which had been in sod for 2 years, lost only 0.20 inch of water and only 0.11 ton of soil per acre; while plot 6, which was cultivated for the third consecutive year, lost 4.74 inches of water and 28.66 tons of soil per acre. Only 2 rains caused run-off from plot 4, while 18 rains caused run-off from plot 6. Plot 5, which had been cultivated for 2 years, and was in sod during 1940, lost 4.47 inches of water per acre—nearly as much as the cultivated plot 6—but only 2.11 tons of soil per acre. It is striking that the new sod during its first year had a heavier water run-off and lost more soil than the cultivated plot during its first year of cultivation following 2 years of sod.

In plots 1, 2, and 3, where strips of varying widths occurred, the soil loss varied inversely with the width of the strips; that is, the wider the sod strip the less the total soil loss.

In 1940, heavy run-off and soil losses occurred during the months of April, May, June, and August.

DENSITY METHOD FOR DETERMINATION OF SOIL CONTENT OF RUNOFF AND SOIL MOISTURE

K. B. Sanders and A. L. Kennedy

A quick field method for determining soil content of runoff, and soil moisture, based on difference in density between water and soil,

has been developed in connection with erosion studies carried on by means of portable artificial-rainfall equipment on 1/20-acre plots.[1] Theoretically, it is possible to calculate the quantity of soil in a soil-water mixture by ascertaining the difference in weight between equal volumes of water and soil-water mixture and then multiplying by the following factor:

$$\frac{\text{soil density}}{(\text{soil density})-(\text{water density})} = \text{factor}$$

Densities of 8 out of 9 Tennessee soils ranged between 2.6 and 2.7. When density=2.6, factor=1.63. When density=2.7, factor=1.59.

Determinations of soil in soil-water mixtures have been made, through the use of glass bottles of 2- or 3-gallons capacity and a solution balance of 20-kg. capacity and 1-gm. sensitivity. The volume was reproduced by complete filling of the bottle each time. Trials in the laboratory indicate that with 1-percent or more soil concentration, the quantity of soil in a soil-water mixture can be determined within about 5-percent error. When the soil concentration is less than 1 percent, the percentage error in the determination increases steeply. Results with actual runoff in the field, though usually considered satisfactory for the purpose, have not been as accurate as in the laboratory trials. Results by the density method tend to be low.

The soil content in the runoff from cultivated plots following heavy rains is nearly always more than 1-percent soil concentration, while that from thick-growing crops is usually less than 1 percent. It appears, therefore, that the density method for determining the soil content of runoff will be limited to cultivated areas.

The density method has been used also for the determination of soil moisture. Promising results have been obtained with moist-field soils, but poor results with air-dry soils. Results tend to be high, especially in the case of the air-dry soils.

CALIBRATION OF SMALL-FRACTION RUNOFF DIVISORS

K. B. Sanders and A. L. Kennedy

Six units of a model of this type of divisor, which catches about 1/1000 of the total runoff, and which operates automatically during runoff rains with water from a roof, have been in use with 1/20-acre plots since January 1, 1938.[2] Each divisor operates as follows:

Runoff from a plot is concentrated in a discharge flume, at the lower end of which the runoff stream drops vertically through a discharge aperture. A sampling trough, operated by a tipping-bucket drive whose source of power is a constant-head reservoir of water derived from rainfall on the roof, is flipped horizontally

[1] Kennedy, A. L. Equipment for runoff measurements. Ag. Eng. Jour., June, 1941. p. 218.

[2] Kennedy, A. L., and Sanders, K. B. Runoff sampling and measuring device. Tenn. Agr. Exp. Sta., An. Rept. 1939. p. 13.

under the discharge aperture and through the runoff stream at constant intervals. At each flip the sampling trough catches, and thereafter delivers to an aliquot can located at one side, a portion of the runoff. The sampling trough is sloped toward the delivery end and closed at the other end. To avoid loss of catch by splashing, the sampling trough is made narrow at the top and flared toward the bottom and is equipped with deflectors. Each divisor is calibrated as follows: Water from a city main is run through the divisor flume to simulate runoff, while the reservoir head is maintained with water from a hose. The quantity of flow from the main is recorded with a Niagara water meter, and the duration of flow with a stop clock. The aliquot fraction caught and delivered by the divisor to a catch can is weighed on a solution balance to the nearest .01 pound. The quantity caught per flip can be reproduced about as well from 2 flips as from any greater even number of flips. It is considered advisable, however, in making calibrations for percentage catch, to collect the catch from a minimum of 10 flips per trial, to catch a minimum of 1 pound per trial, and to make 3 separate trials.

The fraction caught by the divisors is approximately 0.1 percent. The variation in percentage catch at different trials at one rate of runoff flow does not exceed 6 percent, and usually is only 2 or 3 percent. The variation in percentage catch in separate trials at slow contrasted with rapid runoff flow rates is no greater than the variations at one rate of flow. Percentage catch appears to be directly proportional to the flipping frequency of the sampling trough.

HOME PRODUCTION OF FOOD SUPPLIES

Crossville

J. J. Bird

DIET-HEALTH

During the period 1936 to 1939, inclusive, the Home Production of Food Supplies Project was conducted with the cooperation of 12 homestead families whose farm operations were completely planned by the Experiment Station and who were paid to do experimental work on these farms. This phase of the project was terminated December 31, 1939, and the study of the diet-health phase extended to 160 families representing 800 individuals in 11 communities, including the Cumberland Homesteads and covering the major portion of the county. The large number of individuals was thought necessary to compensate in some degree for the errors inherent in mass diet studies of any kind. Family eligibility was based on willingness to cooperate and the presence in the family of two or more children 12 years old or under. Record-keeping was simplified.

Because of the difficulty in getting satisfactory cooperation on this type of work, due to the record-keeping involved and the neces-

sary physical examinations, a respected resident leader in each community was employed to assist in securing cooperators. This leader was used also to call families together for meetings, to assist in record-keeping, and to facilitate field work of the Station staff wherever possible. Compensation to cooperating families consisted of limited amounts of phosphate, to be used in a specified manner, and the physical examination given the children, which was stressed as being of health-insurance value.

Because of inability to keep records, lack of interest, necessity for blood sampling, and other difficulties, 50 families dropped out before the end of the year.

No effort was made to influence diets, the object being to determine the diet tendency of each family with a view to grouping families by diet types and effecting diet revisions later. Records of family food consumption were obtained by the weekly method previously used. In addition, detailed 3-day individual diet records were obtained on 200 individuals during December.

A house trailer was equipped to facilitate physical examinations of all cooperating individuals. Physical examinations and histories were obtained on 333 individuals and physical examinations alone on 348 during October, November, and December. Dr. J. P. Dietrich, a recent medical graduate, joined the staff July 1 to take charge of the medical phase of the work.

On account of the necessity for bone-density observations and complete blood analyses, cooperation with the Rockefeller Foundation in its studies in human nutrition, now being conducted through Vanderbilt University, proved desirable. The office was equipped as a laboratory where 30-cc. blood samples from 215 individuals were analyzed for red-cell count, hemoglobin content, packed-cell volume, and vitamin C by a laboratory technician. Blood and urine samples were analyzed further at Vanderbilt University for blood vitamin A, phosphorus, phosphotase, calcium, protein, and urine B_1 and albumin. X-ray pictures with the aluminum-wedge comparison were taken of wrist and ankle of 230 individuals for bone-density studies. A portable X-ray machine from Vanderbilt University hospital was used.

In general, blood calcium and phosphorus were within normal ranges, blood protein was adequate, vitamin C normal, and bone densities within normal range. Further statistical analysis of the data is yet to be made by the cooperating agency in conjunction with similar data obtained elsewhere through the Rockefeller Foundation investigations. Considering the fact that practically all plant and animal life on the Plateau registers extreme symptoms of mineral deficiency, the above results with human beings living largely on local products is surprising. Practically no meat was being consumed

by those under test, yet the blood protein was high. The chief source of protein appeared to be dried beans, the consumption of this commodity being found to reach 122 pounds per adult equivalent per year in one case. Dried beans are also an important source of phosphorus.

Physical examinations without blood sampling will be continued. A large percentage of families were found to be unwilling to continue cooperation if further blood sampling was required.

FIELD CROPS

Eight acres of level land were leased from a homesteader for crop experiments. This work heretofore was conducted on the 12 Homestead farms. Because of the limited land area available and the interest in the potato crop, this land was limited largely to potato-production experiments in which fertilizer rate, fertilizer formula, spray, and rotation trials were integrated for maximum results. Potato variety trials, including 24 varieties and seedlings, were also conducted here, as well as plant-spacing tests. Scab-resistance trials were conducted with 17 varieties and seedlings on another farm having an ideal scab environment for such work. The fertilizer rate, fertilizer formula, spray, and rotation trials were replicated 6, 6, 4, 1 times respectively. The variety-yield test was replicated 8 times and the scab-resistance test 6 times.

The significance of the *combination* of spray and fertilizer on yield was indicated in the first season's results (table 3). Not only were yields closely related to number of bordeaux sprays, but increasing the number of sprays increased the profitableness of heavier

TABLE 3—*Effects of fertilizer rate, fertilizer formula, and spray on potato yields, Crossville,* 1940.

Per-acre treatment	0-Bordeaux		3-Bordeaux		7-Bordeaux		Average	
	Total	No. 1	Total	No. 1	Total	No. 1	Total	No. 1
	Bushels	Bushels	Bushels	Bushels	Bushels	Bushels	Bushels	Bushels
500 lbs. 4-10-4	153	102	173	136	161	122	162	**120**
1000 lbs. 4-10-4	171	126	208	162	219	172	199	**153**
1500 lbs. 4-10-4	193	145	237	185	253	203	228	**178**
2000 lbs. 4-10-4	195	143	262	203	282	218	**246**	**188**
2500 lbs. 4-10-4	191	141	272	213	291	223	251	**192**
3000 lbs. 4-10-4	189	137	263	207	302	231	**252**	**192**
Average	182	132	236	184	251	195	.....	.....
1000 lbs. 4-10-4	184	137	219	162	242	164	**215**	**154**
1000 lbs. 8-10-4	163	117	248	178	281	185	231	**159**
1000 lbs. 4-5-4	141	108	190	131	216	151	**182**	**130**
1000 lbs. 4-15-4	168	92	223	147	231	148	**207**	**129**
1000 lbs. 4-10-8	156	114	215	151	203	138	**191**	**134**
1000 lbs. 4-10-12	191	143	240	157	**254**	177	**228**	**159**
Average	167	119	223	154	238	160	.....	.....

applications of fertilizer. The yield difference between applications of 500 pounds and 3000 pounds per acre of a 4-10-4 fertilizer, all plots included, was 90 bushels. The yield difference between all plots receiving no bordeaux and 7 bordeaux sprays was 69 bushels. The yield difference between plots receiving 500 pounds of fertilizer and

TABLE 4—*Potato leaf hoppers per plant under 0-bordeaux, 3-bordeaux, and 7-bordeaux sprays, Crossville, 1940.*

Dates of observation	0-Bordeaux		3-Bordeaux		7-Bordeaux	
	No. of counts	Hoppers per plant	No. of counts	Hoppers per plant	No. of counts	Hoppers per plant
June 11-12	60	6.2	24	4.0	24	3.3
June 26-27	80	60.0	24	7.0	24	1.3
July 10-11	71	312.0	24	2.0	24	1.1
July 25-26	0	Plants dead	16	3.5	24	0.9
Plants dying	July 5		July 20		July 30	
Average yield	174		229		245	

no bordeaux and those receiving 3000 pounds of fertilizer and 7 sprays was 149 bushels per acre. The spray-fertilizer formula relationship was less pronounced, and even tentative conclusions cannot be drawn from one season's results. In connection with the spray experiments, 4 leaf-hopper counts were made at biweekly intervals, beginning June 11. These results are presented in table 4. Leaf hoppers numbered over 1000 per plant in 4 plant counts July 10-11 on no-bordeaux plots. Spray plots were 36 rows wide. Three bordeaux sprays apparently controlled the leaf hopper during the 1940 season. However, early blight was not controlled by 3 sprays, and the life of the plants and yield were influenced by it.

In the potato variety trials certain of the recent introductions maintained the lead in yield established in 1939, notably the Pontiac, Sequoia, and Chippewa. Bliss Triumph, an old variety, produced equally well this season. Irish Cobbler was used as a check in the scab-resistance plots and was 100-percent scabbed in each of the 6 replications. Three foreign varieties and 13 seedlings known to be somewhat resistant were included. Twelve of the seedlings and the foreign varieties showed marked resistance, 3 being completely free from scab. These are being tried elsewhere for scab resistance by the United States Department of Agriculture.

Plant spacings of 10, 14, and 17 inches in 32-inch rows replicated 3 times yielded 276, 235, and 226 bushels per acre, with 181, 128, and 141 bushels of U. S. No. 1 respectively. Irish Cobbler was used in this test.

In cooperation with the United States Department of Agriculture, through Mr. L. S. Mayer, 50 top crosses of Yellow Thompson Prolific corn lines were tested for yield in 10 replications on 3 acres. Assistance

was also given in locating farm cooperators for corn-potash tests directed by Dr. Eric Winters.

LIVESTOCK

Permanent-pasture seedings were completed on the Mineral Deficiency Farm, making a total pasture area of approximately 170 acres. The liming of the entire area at the rate of 2 tons per acre was completed. Twenty-eight acres of low semi-peat land, ditch-drained in 1939, was seeded to redtop, and an excellent growth was obtained by the end of the season. This type of land is considered unproductive on the Plateau at present.

The initial group of 24 head of young beef heifers was purchased in November. Twelve of these were obtained about Nashville and 12 obtained from the local region. These cattle were divided into 3 lots of 8 each, with 4 Nashville and 4 Plateau heifers making up each lot. Lot 1 was put on low-phosphate roughage, lot 2 on low-phosphate roughage plus dicalcium phosphate, and lot 3 on high-phosphate roughage.

The weather during the growing season was characterized by an April and July precipitation far below normal. The high point in temperature, 94 degrees, was reached on July 29. The temperature reached 90 degrees five times during July and August. As a whole, crops were excellent, the early potato crop particularly so.

AGRICULTURAL ENGINEERING

M. A. Sharp

Studies of equipment for handling legumes were conducted by H. A. Arnold.

Legume-Seed Scarifier.—This scarifier was designed especially for sericea, but does good work on sweet clover. It consists mainly of a grinding wheel and a rubber pad which fits against the side of the wheel. Seed enters a narrow space between the wheel and the pad, being fed in at the center of the wheel. A separating attachment cleans the seed sufficiently for farm use as it is scarified. Germination above 90 percent has been obtained consistently.

Lime and Fertilizer Spreader.—This machine is constructed from used auto parts, and is sturdy, easy to make, and efficient. It is complete except for slight modifications required in size and location of feed spouts from the hopper.

Legume Silage Experiments.—The work on this project consists of design and operation of special machinery for harvesting green legumes and putting them into the silo. In all cases, phosphoric acid was used as a preservative. Alfalfa was put up on the Macmor and Wattenbarger farms near Knoxville, and Korean lespedeza on the

Garrison farm at Byington. Several silos were filled at the Greeneville Experiment Station and at the University of Tennessee Farm, Knoxville. Several devices for applying acid and molasses have been used, but none of them have been entirely satisfactory. This project will require study over a period of years as new developments arise.

Milk Pasteurizer.—This project was carried over from 1939 and completed in August. The pasteurizer consists of 6 vats in which milk may be held at any desired temperature. All temperature controls are automatic and accurate to ½° F. The vats and water tanks are made of stainless steel.

Erosivity.—Work on erosivity and infiltration capacity of soils under the supervision of A. L. Kennedy, was continued from 1939. The rotary nozzle, which delivers water in a square area, has been developed to a satisfactory basis. The volume now used is 3.7 inches per hour. A plow has been developed for placing the border strips, and a 1/20-acre plot can be laid out in a few minutes. The layout plan has been developed so that two plots may be set up side by side and operated at the same time, making it possible to get readings on adjacent plots which have had different treatment. The metering device to measure soil and water losses has been developed to a satisfactory point and a plan for determining soil and water losses by direct reading in the field in a few minutes has been perfected. It is possible now to set up the machinery on two plots, apply water at the rate of 3.7 inches per hour for 30 minutes or longer, and determine accurately the infiltration capacity and soil and water loss per acre in less than two hours.

Two trips were made with this machinery to Abingdon, Virginia, last summer for cooperative work with the Virginia Polytechnic Institute and the U. S. Department of Agriculture. Plans are being made for taking readings on TVA test demonstration farms in cooperation with the Agricultural Extension Service.

ANIMAL HUSBANDRY

M. Jacob

BEEF CATTLE FEEDING EXPERIMENT AT KNOXVILLE

In November, 1938, a beef cattle feeding experiment was begun at the Knoxville Station with 2-year-old-steers to compare—

1. Acre yields of beef from corn harvested in various forms and combinations.

2. Costs and profitableness of acre-beef yields from corn fed in various forms and combinations.

The first test was completed in March, 1939, and the results have been briefly reported. The second test was begun in the fall of 1939 and was completed in March, 1940.

For the second trial there was an additional lot of steers, designated as lot 5. As during the previous year, there were 7 uniform, 2-year-old steers of similar grade in each lot, which were fed for a period of 150 days. The rations for 4 lots were the same as in the first trial. Lot 1 was fed corn silage and an average of 4.97 pounds of cottonseed meal per steer per day. Lot 2 was fed corn silage and enough cottonseed meal to balance the ration, which was 1.65 pounds per steer per day. Lot 3 was fed corn silage and cottonseed meal in the same amounts as lot 2, and legume (lespedeza) hay. Lot 4 was fed corn stover and crushed corn-cob-shuck meal in the same amount as stover. This lot received cottonseed meal and lespedeza hay in the same amount as lot 3. Lot 5 was fed cottonseed meal and lespedeza hay in the same amounts as lots 3 and 4, and a full feed of ground snapped corn.

The returns per acre of corn, less processing cost, for feeding were $40.50 for lot 1, $38.22 for lot 2, $34.29 for lot 3, $21.93 for lot 4, and $32.30 for lot 5.

This experiment will be continued for at least one more year before publication of complete results.

STEER FEEDING AND GRAZING EXPERIMENT AT COLUMBIA

In the fall of 1937 there was begun at the Middle Tennessee Station, Columbia, a winter feeding and summer grazing experiment to determine the most satisfactory ration for wintering yearling steers that are to be finished on grass the following summer. The experiment has been under way 3 years, 30 uniform steers of good grade being used each year. In the fall the steers were divided into 3 groups, designated as lots 1, 2, and 3, which were subsequently fed and handled as follows:

Lot 1—Fed a ration during the winter period (December to April) consisting of 20 pounds of silage and 8 pounds of stover, or low-grade hay, per steer per day.

Lot 2—Fed a ration during the winter period (December to April) consisting of 1½ pounds of cottonseed meal per steer per day, and silage and stover, or low-grade hay, in the same amounts as lot 1.

Lot 3—Fed a ration during the winter period (December to April) consisting of 1 pound of cottonseed meal and 4 pounds of corn-cob-shuck meal per steer per day, and silage and stover, or low-grade hay, in the same amounts as lots 1 and 2.

At the beginning of the summer grazing period, 5 uniform steers were selected from each of the 3 lots that had been winter-fed. These 15 steers were placed together for summer grazing and designated as lot A. The remaining 15 steers in the 3 winter feeding lots were placed together for summer grazing and designated as lot B. Lot A was finished on grass without grain. Lot B was finished on grass, but

TABLE 5—*Data on steers finished in August, 1938.*

Item	Lot A Pasture and no grain			Lot B Pasture and 5 pounds corn-cob-shuck meal		
	Lot 1 Wintered on no grain	Lot 2 Wintered on C. S. M.	Lot 3 Wintered on C. S. M. and corn-cob-shuck meal	Lot 1 Wintered on no grain	Lot 2 Wintered on C. S. M.	Lot 3 Wintered on C. S. M. and corn-cob-shuck meal
Av. weight Nov. 30, 1937 (lbs.)	725.8	729.5	701.6	728.0	728.0	719.2
Av. winter gains, 126 days (lbs.)	115.0	153.0	214.0	120.2	125.4	193.4
Av. summer gains, 135 days (lbs.)	181.2	162.5	165.4	211.7	190.6	161.4
Av. gain, winter and summer, 261 da. (lbs.)	296.2	315.5	379.4	332.0	316.0	354.8
Cost per 100 lbs. winter gain	$8.54	$8.07	$7.43	$8.17	$9.84	$8.22
Cost per 100 lbs. summer gain	$4.86	$5.42	$5.32	$6.19	$6.88	$8.13
Cost per 100 lbs. winter and summer gains	$6.29	$6.70	$6.51	$6.91	$8.06	$8.17
Av. appraisal per 100 pounds at end of grazing period	$8.01	$8.13	$8.06	$8.17	$8.11	$8.24
Net profit per steer, on basis of appraisal	$10.76	$10.90	$11.58	$11.02	$6.59	$7.46

TABLE 6—*Data on steers finished in August, 1939.*

Item	Lot A Pasture and no grain			Lot B Pasture and 5 pounds corn-cob-shuck meal		
	Lot 1 Wintered on no grain	Lot 2 Wintered on C. S. M.	Lot 3 Wintered on C. S. M. and corn-cob-shuck meal	Lot 1 Wintered on no grain	Lot 2 Wintered on C. S. M.	Lot 3 Wintered on C. S. M. and corn-cob-shuck meal
Av. weight Nov. 7, 1938 (lbs.)	654.4	658.4	644.0	667.4	669.6	686.0
Av. winter gains, 164 days (lbs.)	40.4	177.2	207.0	43.6	164.6	171.4
Av. summer gains, 128 days (lbs.)	190.2	129.4	91.0	235.0	158.8	117.6
Av. winter and summer gains, 292 da. (lbs.)	230.6	306.6	298.0	278.6	323.4	289.0
Cost per 100 lbs. winter gain	$26.80	$7.91	$8.77	$24.83	$8.51	$10.59
Cost per 100 lbs. summer gain	$4.31	$6.34	$9.01	$5.24	$7.75	$10.47
Cost per 100 lbs. winter and summer gains	$8.25	$7.24	$8.84	$8.30	$8.14	$10.54
Av. appraisal per 100 lbs. at end of grazing period	$7.22	$7.41	$7.83	$7.44	$7.63	$7.73
Net profit per steer, on basis of appraisal	$4.22	$0.08	$0.90	$2.81	$0.78	$6.55

was fed in addition 5 pounds of corn-cob-shuck meal per steer per day. All lots were marketed off grass during the month of August.

Tables 5 and 6 give information on the results obtained from the first and second trials.

Because of an accident among the steers in one lot, the third trial is not comparable to the first and second; hence the experiment will be continued during 1940-41 so that there will be at least 3 trials from which definite conclusions may be drawn.

BEEF CATTLE FEEDING EXPERIMENT AT COLUMBIA

The beef cattle feeding experiment begun at the Middle Tennessee Station, Columbia, in December, 1937, and reported in 1938, comparing alfalfa hay with corn-sorghum silage in a winter fattening ration for yearling steers, was repeated during the winters of 1938-39 and 1939-40, using the same number of steers in each lot for both trials.

Lot 1—Fed corn-cob-shuck-meal and alfalfa hay.

Lot 2—Fed a grain mixture of 1 part by weight of cottonseed meal and 2 parts by weight of corn-cob-shuck meal and corn-sorghum silage.

The steers finished in May 1939 had been on feed 177 days. The steers in lot 1 had an average initial weight of 727.2 pounds, made an average daily gain of 1.460 pounds per steer, appraised at $8.52 per hundredweight, and showed a net profit of $5.78 per head. The steers in lot 2 had an average initial weight of 719.2 pounds per steer, made an average daily gain of 1.684 pounds per steer, appraised at $9.025 per hundredweight, and showed a net profit of $13.01 per head.

The steers finished in April 1940 had been on feed 170 days. The steers in lot 1 had an average initial weight of 734.4 pounds, made an average daily gain of 1.583 pounds per steer, appraised at $8.40 per hundredweight, and showed a net profit of $1.80 per head. The steers in lot 2 had an average initial weight of 736.3 pounds, made an average daily gain of 1.699 pounds per steer, appraised at $8.50 per hundredweight, and showed a net profit of $0.41 per head. In this trial, feed costs for lot 2 were slightly higher than for lot 1.

This experiment is being continued for another year.

BEEF CATTLE FEEDING EXPERIMENT AT JACKSON

In December 1939 a beef cattle feeding experiment was begun at the West Tennessee Station, Jackson, to determine the feeding value of dehydrated sweetpotatoes in a fattening ration for yearling steers. Fourteen medium steers were selected and divided into 2 uniform groups, designated as lots 1 and 2.

Lot 1—Fed a daily ration per steer of 10 pounds of corn-sorghum silage and a concentrate mixture consisting of 9 parts by weight of

dehydrated sweetpotatoes and 3 parts by weight of 41-percent cottonseed meal.

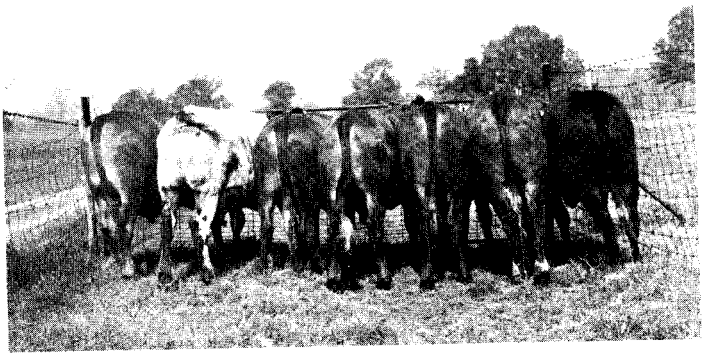

Fig. 2—Lot 1, fed silage, dehydrated sweetpotatoes, and cottonseed meal.

Lot 2—Fed a daily ration per steer of 10 pounds of corn-sorghum silage and a concentrate mixture of 10 parts by weight of corn-cob-shuck meal and 2 parts by weight of 41-percent cottonseed meal.

Fig. 3—Lot 2, fed silage, corn-cob-shuck meal, and cottonseed meal.

The total weight of concentrates fed, an average of 13.8 pounds per steer per day, was the same for both lots.

The dehydrated sweetpotatoes for this trial were supplied by the Bureau of Agricultural Chemistry, U. S. D. A., and transported from Laurel, Mississippi, to Jackson, Tennessee, by the G. M. & N. Railway.

A valuation of $5.00 per ton for silage and $20.00 per ton for

the concentrate mixtures fed to both lots were used in preparing tables 7 and 8, covering the first year's trial.

TABLE 7—*Weights, gains, and cost of gains of steers.*

Item	Lot 1	Lot 2
Number of steers	7	7
Number of days in experiment	150	150
Average initial weight, December 17 (lbs.)	649	647
Average weight at end of 150-day period (lbs.)	861	839
Average gain per steer (lbs.)	212	192
Average daily gain per steer (lbs.)	1.41	1.28
Cost per cwt. gain	$11.53	$12.73

TABLE 8—*Financial statement, steer feeding experiment.*

Item	Lot 1	Lot 2
Average initial cost per steer, $6 per cwt.	$38.94	$38.82
Average feed cost per steer	24.45	24.45
Total cost per steer, initial and feed	63.39	63.27
Necessary selling price per cwt., with 3% shrinkage to break even	7.59	7.77

The steers in lot 1 showed a little more finish and, on a warm-carcass-weight basis, dressed 58.28 percent, as against 57.43 percent for lot 2. Both lots of steers sold at $9.00 per hundredweight.

This work will be continued for further study on feeding dehydrated sweetpotatoes in a fattening ration for beef cattle.

SHEEP BREEDING EXPERIMENT AT KNOXVILLE

An experiment in sheep breeding, begun at the Knoxville Station in August 1938 is being continued. The object is to determine the influence of gonado-tropic hormone of pregnant-mare serum on lambing when injected subcutaneously into mature ewes at the beginning of the breeding season. The purebred breeding flock, consisting of Hampshires and Southdowns, is being used.

Each year the ewes were divided into 2 uniform lots, on the basis of age, condition, and breeding history. Of the ewes lambing in 1939, there were 15 Hampshires and 3 Southdowns in the treated lot, and 16 Hampshires and 5 Southdowns in the control lot. Of the ewes lambing in 1940, there were 16 Hampshires and 7 Southdowns in the treated lot, and 15 Hampshires and 6 Southdowns in the control lot. Thus, in the 2 years there were 41 ewes in the treated lots and 42 ewes in the control lots.

All ewes in the treated lots were given 400 rat units of gonado-tropic hormone, divided into two equal doses, injected at an interval of 16 days immediately preceding the beginning of the breeding season.

For the 2 years, the average lambing date for the ewes in the

treated lots was January 30, and for those in the control lot, February 4.

This experiment will be continued, with some modification, for another year.

SHEEP BREEDING EXPERIMENT AT COLUMBIA

In July 1939 a sheep breeding experiment was begun at the Middle Tennessee Station, Columbia, to study the comparative value of Middle Tennessee (native) grade ewes, Cumberland Plateau (mountain) grade ewes, and Northwestern (Montana) grade ewes when bred to good purebred, mutton-type rams for early spring lamb production.

Forty-one ewes, varying in age from 1 to 6 years, were selected from the breeding flock at the Middle Tennessee Station to represent lot 1, or native ewes; 42 black-faced yearling ewes, bred on the Cumberland Plateau, were purchased at Crossville, Tennessee, to represent lot 2, or the mountain ewes; and 50 yearling, range-bred ewes were purchased out of a shipment from Montana to represent lot 3, or Northwestern ewes.

The 3 lots of ewes were grazed together. Good purebred Hampshire rams were turned in with the flock on July 29, 1939, and were left with the ewes during the breeding period, which was terminated on October 31, 1939.

The 3 lots of ewes were not wholly comparable on account of the variation in age among the ewes in lot 1. This lot, however, did include 7 yearlings which are used as a comparison with lots 2 and 3. These last two lots are definitely comparable.

Tables 9 and 10 reveal a few results for the first year of this experiment which are of practical significance.

This study will be continued until definite conclusions can be drawn.

TABLE 9—*Data on ewes at Columbia.*

Item	Lot 1 (native)	Lot 2 (mountain)	Lot 3 (northwestern)
Number of yearling ewes in each lot July 29, 1939	7	42	50
Number of ewes died in each lot	0	4	4
Av. weight of ewes at beginning of experiment (lbs.)	111.7	84.9	99.0
Av. weight of ewes at end of breeding period (lbs.)	116.4	112.0	125.8
Av. gain of ewes during breeding period (lbs.)	4.7	27.1	26.8
Av. weight of breeding ewes at weaning time (lbs.)	116.0	103.0	119.0
Av. gain of ewes during year (lbs.)	4.3	20.0	21.0
Av. weight of fleece from ewes (lbs.)	5.5	5.88	7.47

TABLE 10—*Data on ewes and lambs at Columbia.*

Item	Lot 1 (native)	Lot 2 (mountain)	Lot 3 (noth-western)
Average lambing date	Jan. 21	Jan. 30	Feb. 5
Ewes lambed (percentage)	100.0	66.6	78.0
Av. weight of lambs at birth (lbs.)	8.925	8.43	9.73
Av. weight of lambs when marketed (lbs)	74.9	68.0	74.1
Grade of lambs when marketed (percentage)			
Choice	42.9	10.7	47.4
Good	42.9	53.6	36.8
Medium	14.2	25.0	13.2
Common	0.0	10.7	2.6
Av. net return per lamb	$8.33	$6.22	$7.96
Av. net return per fleece from ewes @ 35.2c	$1.92	$2.07	$2.63
Av. net return per ewe (fleece and lambs)	$10.25	$8.29	$10.59

PIG FEEDING AND GRAZING EXPERIMENT AT JACKSON

The pig feeding and grazing experiment, comparing different grain and pasture combinations as fattening rations, begun at the West Tennessee Station, Jackson, in 1937 and reported in 1938, was repeated the next year with two of the rations.

This trial was conducted with 2 uniform lots of pigs and extended from December 1, 1938, to March 31, 1939. The rations for the 2 lots were as follows:

Lot 1—Shelled corn and a mixture of 2 parts by weight of high-grade tankage and 1 part by weight of cottonseed meal, free choice, and crimson clover and ryegrass pasture.

TABLE 11—*Average daily ration of pigs.*

Feed	Lot 1	Lot 2
	Pounds	Pounds
Shelled corn	5.33	
Ground barley		4.96
Protein supplement	.69	.81

TABLE 12—*Weights, gains, and other items in pig feeding experiment.*

Item	Lot 1	Lot 2
Number of hogs	5	5
Number of days in experiment	120	120
Av. initial weight, December 1, 1938 (lbs.)	22	20
Av. final weight, March 31, 1939 (lbs.)	235	214
Av. gain per hog, 120 days (lbs.)	213	194
Av. daily gain per hog, 120 days (lbs.)	1.77	1.62
Initial cost per hog @ $8.00 per cwt.	$1.76	$1.60
Total feed cost per hog	$8.36	$8.23
Total cost (hog and feed), 120 days	$10.12	$9.83
Cost per 100 lbs. gain	$3.92	$4.24
Feed for 100 lbs. gain:		
Corn (lbs.)	300	
Barley (lbs.)		309
Protein supplement (lbs.)	39	50
Necessary selling price per 100 lbs.	$4.31	$4.59

Lot 2—Barley and a mixture of 2 parts by weight of high-grade tankage and 1 part by weight of cottonseed meal, free choice, and crimson clover and ryegrass pasture.

Tables 11 and 12, which give detailed information on this trial, were based in part on average feed prices of $20.00 per ton each for shelled corn and barley, and $46.67 per ton for protein supplement.

Studies on economical grain and pasture combinations for fattening pigs are being continued.

JACK-STOCK AND MULE-PRODUCTION STUDIES

The purpose for which the jack-stock and mule-production studies were undertaken, at Columbia, is clearly stated in the Annual Report for 1938. The work is now well under way, and even though progress in a project of this kind is relatively slow, significant observations are already possible.

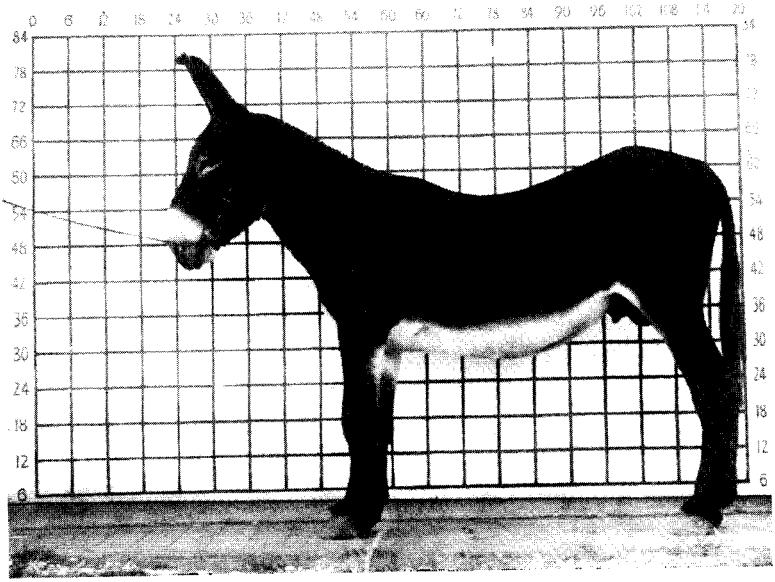

Fig. 4—Jack, U. T. Logan No. 34134, 25-year-old herd sire, by General Logan No. 4914.

The original breeding unit in 1937 consisted of 1 herd jack and 11 mature jennets. Through foals born and some purchases, the number of animals has been increased to 2 herd jacks, 5 yearling jacks, 2 jack foals, 12 mature jennets, 3 yearling jennets, 3 jennet foals, 7 Tennes-

see Walking mares, 1 Walking stallion (2-year-old), 1 horse foal and 3 yearling mules.

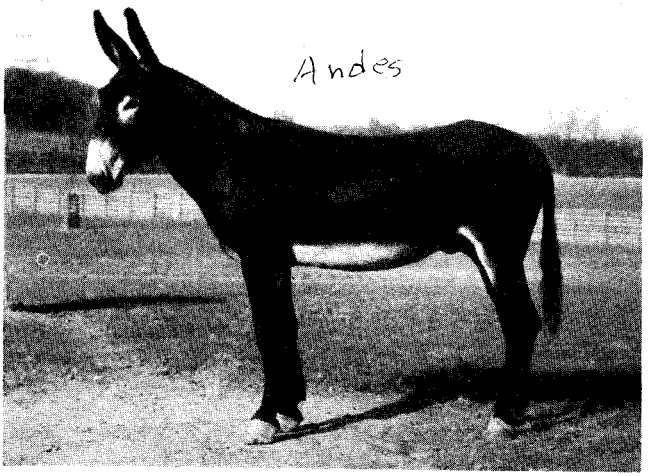

Fig. 5—Jack, Limestone U. T. Monarch No. 32973, 3-year-old herd sire.

This increase has necessitated additions to the physical equipment, which now includes approximately 154 acres of good land, 3 livestock barns designed to meet special requirements, stationary measuring chart for growth studies, tool shed, scales, and a cottage for the Assistant Superintendent.

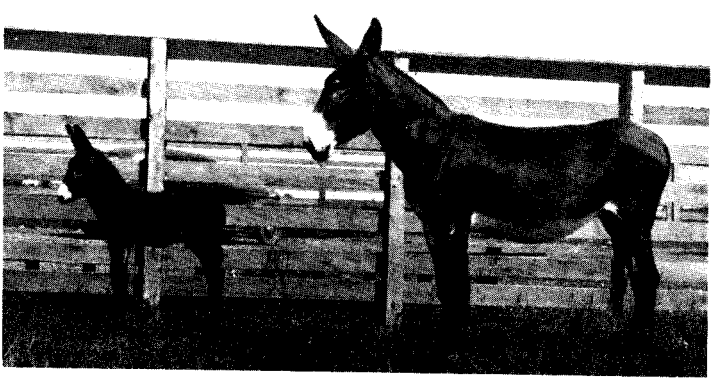

Fig. 6—Jennet, Young Miss Jordan No. 34355, and jennet foal.

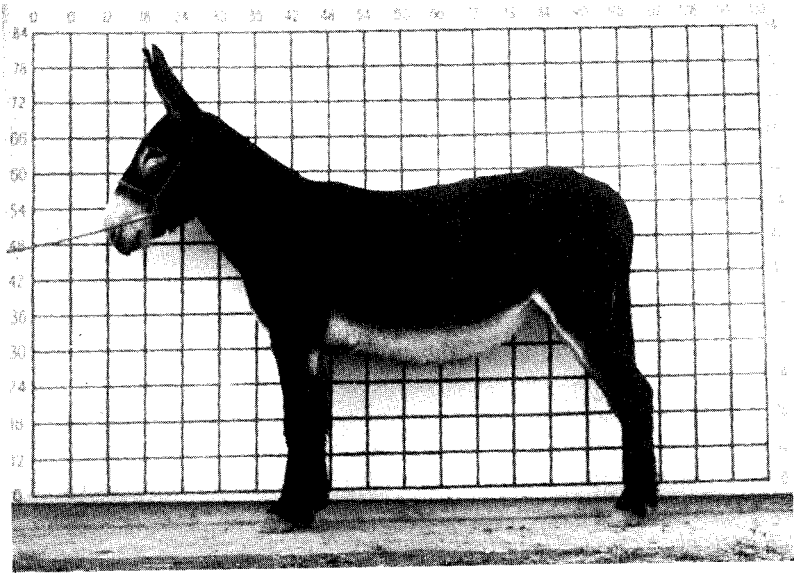

Fig. 7—Miss Derryberry No. 34357, 5-year-old foundation jennet.

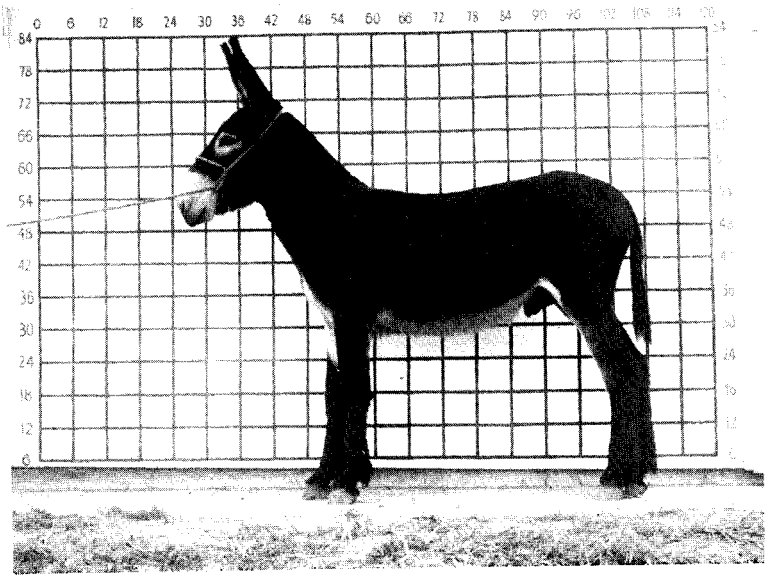

Fig. 8—U. T. Logan Again No. 34361, yearling jack.

The type and quality of jack-stock produced up to the present time from matings of the foundation animals appear very satisfactory, as the yearling jacks and jennets are outstanding in individual appearance. Their real merit will be determined later, however, by the offspring which they in turn produce of their own kind and of mules, out of light and heavy mares, sired by Station-bred jacks. In order to have the advantage of more animals for study, the Station accepts a limited number of approved outside mares and jennets for service.

Compared with work on other kinds of livestock, very little has been done on the physiology of reproduction as it applies to jack-stock, and dependable literature on the subject is even more limited; hence, the subject provides a relatively new and unexplored field.

In order to avoid any possibility of error, the following data are based entirely on Station-owned animals, which are constantly under observation by Station personnel:

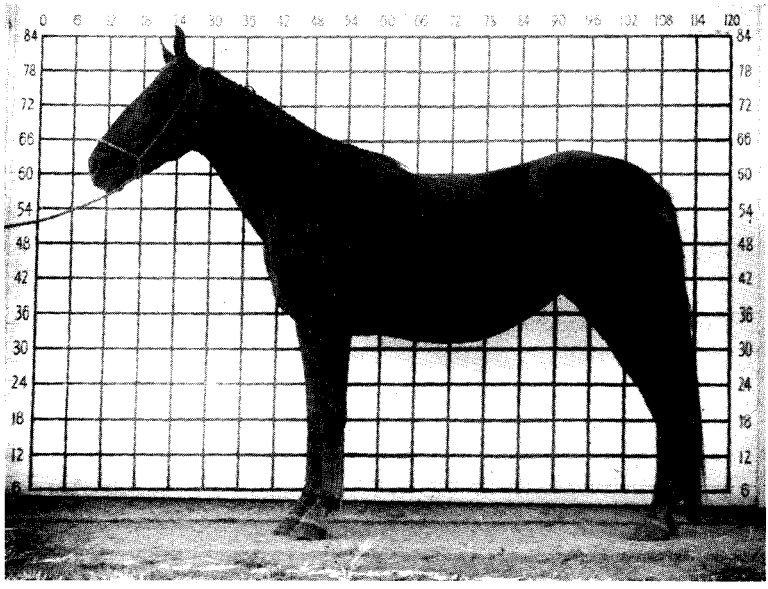

Fig. 9—Natacha Allen No. 380208, 3-year-old Tennessee walking mare, being used for mule production.

Seventeen gestation periods in jennets varied from 340 days to 393 days, averaging 367.8 days.

Oestrus cycles in jennets varied from 17 days to 28 days, averaging 22.5 days. In mares the variation was from 18 to 28 days, or an average of 23.5 days.

The Cuboni test (urine test for pregnancy), made on 22 jennets,

at an average of 162.9 days following the last service, were found to be 95.4 percent accurate. For 13 mares, the Cuboni test for pregnancy, made at an average of 174 days following the last service, was 92.3 percent accurate.

The birth weight of 8 jack foals varied from 60 to 102 pounds, an average of 82.25 pounds. For jennets, it varied from 60 to 94 pounds, an average of 81.1 pounds.

Under the Station system of feeding and management, 5 jack foals made an average daily gain in weight, from day of birth until exactly 1 year old, of 1.3 pounds. Three jennet foals, for a similar period, made an average daily gain of 1.07 pounds.

Artificial insemination is being practiced extensively and constitutes an important part of this study.

DAIRY CATTLE FEEDING AND GRAZING EXPERIMENTS

Experiments in dairy cattle feeding and grazing are being continued at both Middle and West Tennessee Stations and will be reported in the section of the Annual Report devoted to these two stations.

The experimental work with the dairy herd at the Knoxville Station, on the preservation and feeding of different kinds of legume silage, will also be reported in a separate section of this report.

BANG'S DISEASE CONTROL

Agglutination tests for infection of Bang's disease at 90-day intervals have been continued during the past 2 years on the beef and dairy herds, of approximately 100 head, at the Middle Tennessee Station, Columbia; the dairy herd, of approximately 35 head, at the West Tennessee Station, Jackson; and the dairy herd, of approximately 75 head, at Knoxville, without any reactors. The tests were conducted by both Huddleson and tube methods, resulting in practically 100-percent agreement.

Mr. L. R. Neel, Superintendent of the Middle Tennessee Station; Mr. Ben P. Hazlewood, Superintendent of the West Tennessee Station; Mr. W. K. Dinwiddie, Assistant Superintendent of the Jack and Jennet Breeding Farm; and Professor H. R. Duncan, of the Knoxville Station, have continued to give willing and valued assistance. They have made it possible to carry out, and even expand, the large amount of work involved in the animal husbandry research program at the Tennessee Stations.

COMPARISON OF SERICEA SILAGE, ALFALFA SILAGE AND CORN SILAGE FOR DAIRY COWS

S. A. Hinton, C. E. Wylie, and G. A. Shuey

To determine the value of *Lespedeza sericea* as a silage crop and to compare it in feeding value with corn silage and alfalfa silage, two

small silos of 10-tons capacity each were filled with sericea and alfalfa, and a 200-ton concrete silo was used for corn (figure 10).

Fig. 10—Dairy-barn equipment for conducting silage experiments and drying hay.

The two 10-ton silos, at left, were filled with legume silage; the two 200-ton silos were filled with corn silage. The propeller fan in side of barn at right is used for drying hay.

The alfalfa was cut in early bloom stage May 25, 1939, and raked and loaded as quickly as possible. The moisture content of each load was determined by the Stark toluene method. The average at the silo was 66.1 percent. This was raised to 70 percent by the addition of water at the time of filling. The alfalfa was treated with a mixture of 60 pounds of blackstrap molasses and 10 pounds of 80-percent phosphoric acid to each ton of green material. The molasses was diluted with an equal part of water to facilitate flowing, the acid was added, and the mixture applied with a Papec automatic molasses feeder attached to a Blizzard 500 ensilage cutter. The power requirement

for cutting, with a 40-horsepower, 3-phase motor, was 2.01 k. w. h. per ton. In 1940 the power requirements for cutting, with the same equipment, were 1.52 k. w. h. per ton for alfalfa and 2.5 k. w. h. per ton for sericea.

Five days after filling, the temperature of the alfalfa at 15 feet below the top was 92° F.; 7 days after filling it was 94° F. Temperature readings of the sericea 5 feet below the surface were taken at 2-day intervals for 10 days after filling. The highest temperature recorded was 98° F., the seventh day after filling. The temperature 10 days after filling was 91° F.

TABLE 13—*Proximate chemical analyses of corn, alfalfa, and sericea silages on the moisture basis.*

Constituents determined	Corn	Sericea	Alfalfa
	Percent	Percent	Percent
Moisture	75.82	68.79	75.54
Dry matter	24.18	31.21	24.46
pH value	.....	3.99	4.43
Ash (mineral matter)	1.53	1.97	2.42
Crude protein (% N x 6.25)	1.46	4.33	4.47
Crude fat (ether extract)	.....	0.64	0.65
Crude fiber	6.46	10.28	8.86
Nitrogen-free extract	14.11	13.99	8.06

In the feeding trials, 12 cows in milk were selected. These cows were divided into 3 groups as nearly equal as possible as to number, breed, age, size, stage of lactation, milk production, and condition. Two Jerseys and two Holsteins were in each group.

Group 1 was fed 20 pounds per cow per day of corn silage and 10 pounds per cow per day of a grain mixture consisting of equal parts of ground oats, corn meal, wheat bran, and cottonseed meal.

Group 2 was fed 20 pounds per cow per day of sericea silage and 10 pounds per cow per day of grain mixture consisting of 2 parts ground corn, 1 part ground oats, 1 part wheat bran, and ½ part cottonseed meal.

Group 3 was fed 20 pounds per cow per day of alfalfa silage and 10 pounds per cow per day of the same grain mixture as group 2.

All groups were fed all the ground alfalfa hay that they would clean up.

The results of the feeding trials are shown in table 14.

SUMMARY

1. A combination of phosphoric acid and molasses may be a satisfactory preservative for legume silage.

2. The 3 groups of cows made a reasonable milk and butterfat production on each kind of silage—corn, sericea, and alfalfa—and maintained normal body weight and girth for all groups.

3. There was little difference between alfalfa and corn silage in milk and butterfat production. Sericea silage produced less milk and butterfat than the other two silages.

4. Cows receiving legume silage consumed more than the usual amount of hay. The corn-silage group consumed slightly less hay than the legume-silage groups.

TABLE 14—*Results of feeding legume silage to dairy cows.*
November 8, 1939, to April 8, 1940—150 days.

Item	Group 1 Corn silage	Group 2 Sericea silage	Group 3 Alfalfa silage
Cattle			
Number of cows	4	4	4
Weight (pounds) Nov. 8, 1939	4605	4499.7	4476
Weight (pounds) Apr. 8, 1940	4618.3	4670	4434.1
Gain in weight (lbs.)	13.3	160.3	-41.9
Gain per cow per day	.0221	.267	-.0698
Heart girth (inches) Nov. 8, 1939	290	294	293.5
Heart girth (inches) Apr. 8, 1940	297.5	298.5	293.5
Gain in heart girth (inches)	7.5	4.5	0
Feed consumption (pounds)			
Grain	6,000	6,000	6,000
Grain consumed per cow per day	10	10	10
Hay fed	12,754	13,231	13,259
Hay refused	316	78	114
Hay consumed	12,448	13,153	13,145
Hay consumed per cow per day	20.74	21.92	21.91
Silage fed	12,000	12,000	12,000
Silage refused	0	113.5	45
Silage consumed	12,000	11,886.5	11,955
Silage consumed per cow per day	20.00	19.81	19.92
Milk production			
Total days in milk	532	541	540
Total pounds milk produced	15,933.1	14,261.4	17,183.3
Av. pounds milk per cow per day	29.94	26.36	31.82
Av. butterfat test of group, percent	4.38	4.21	4.17
Total pounds butterfat	698.04	600.12	717.10
Av. pounds fat per cow per day	1.31	1.11	1.33

FEEDING STUDIES OF BARN-DRIED VERSUS FIELD-DRIED HAY[2]

C. E. Wylie, S. A. Hinton, and J. A. Schaller.

Experimental work, begun in 1934, looking to the development of a system of drying hay in the barn and testing its feeding value, has been continued. Automatic controls have been used and trials made on the curing of hay to depths greater than 10 feet, which previously was considered the maximum.

Briefly, the barn-curing system consists of air ducts, constructed of lumber on the floor of the hay mow. Partially dried hay from the field is stored as usual in the mow, over the air ducts. An electrically driven blower, connected to the air ducts underlying the hay, forces

[2]Tennessee Valley Authority, cooperating.

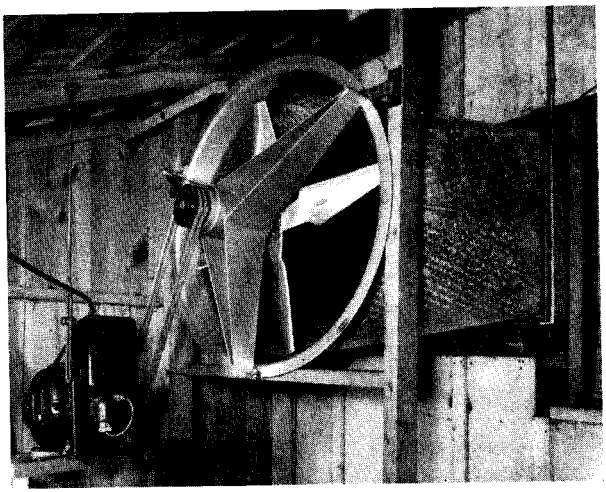

Fig. 11—Propeller-type of fan with motor, for hay drying, installed in shed on side of barn.

air through the hay and removes moisture.

The most promising method of automatic control for the curing equipment embodies the use of a humidistat and a time switch. The humidistat is located outside the barn, and starts or stops the motor according to the relative humidity of the air. The time switch will start or stop the motor for short operating periods during the night or at any time desired by the operator. This method required a minimum amount of attention and worked accurately and satisfactory.

Alfalfa hay was cured without heating or molding to a depth of 10 feet by the use of floor ducts. Hay was cured satisfactorily to a depth of 18 feet by means of flexible ducts placed on top of the first 10 feet.

The average power requirement for curing hay from 45- or 50-percent moisture content to 20-percent moisture content, which is considered safe for storage, was 43 k. w. h. per ton of dried hay. This was with a 5-horsepower motor and a blower delivering 12,000 cubic feet of air per minute.

During each of the 3 winters of 1937-38, 1938-39, 1939-40, ten yearling heifers from the University dairy herd were fed for 150-day periods. These heifers were divided into two groups as nearly equal as possible as to number, breed, age, weight, height, and heart girth. One group was fed all the air-cured hay it would consume, while the other was fed field-cured hay ad libitum. Two pounds of grain and 10 pounds of corn silage per animal per day were fed to each group.

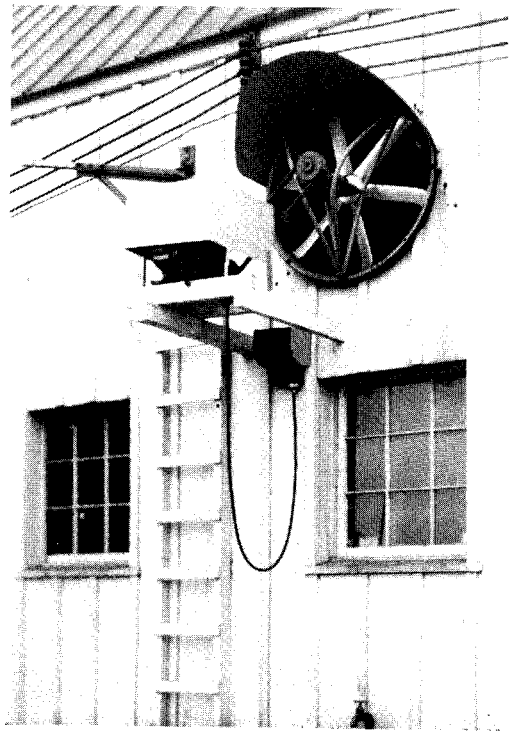

Fig. 12—Propeller-type of fan for hay drying, installed in barn wall.

The heifers in both groups made normal growth, with no marked difference in favor of either group, except that the air-cured group gained slightly more weight in each case—17.4 pounds per heifer in 1937-38, 35.2 pounds per heifer in 1938-39, and 4 pounds per heifer in 1939-40. In 1937-38 and 1938-39 the groups fed field-cured hay gained slightly more in height at withers, while in 1939-40 the group fed air-cured hay gained more. In each instance the difference was less than one-half inch per heifer for the 150-day feeding period. There was no noted difference in the gain in heart girth in 1937-38 or in 1939-40. In 1938-39 the air-cured-hay group showed a gain in heart girth of .85 inch more per animal than the other group.

From a number of analyses made of the two kinds of hay, it was found that the air-cured hay in 1938-39 averaged 48.8 p. p. m. of carotene, while the field-cured hay averaged 18.9 p. p. m.[1] In 1939-40

[1]W. E. Krauss, Ohio Agr. Exp. Sta.

the air-cured samples showed an average carotene content of 28.8 p. p. m., while the field-cured averaged 52.8 p. p. m.[5] In all analyses the protein content of the barn-dried hay has been much higher than that of the field-cured hay. Samples of the barn-dried hay averaged 16.78 percent protein in 1938-39 and 17.88 percent in 1939-40.[6] Samples of the field-cured hay averaged 12.97 percent protein in 1938-39 and 13.09 percent in 1939-40.[6] There was very little difference in the percentages of nitrogen-free extract, water, ash, ether extract, fiber, and phosphorous in the two hays.

TABLE 15—*Results of feeding barn-dried and field-dried hay to dairy heifers.*
Five heifers in each group 120 days 1939-40.

Group	Barn-dried	Field-cured	Difference
	Pounds	Pounds	Pounds
Total hay consumed per heifer	1666	1718	52
Total concentrates consumed per heifer	240	240	0
Total corn silage consumed per heifer	1200	1200	0
Gain in weight per heifer[1]	166	162	4
	Inches	Inches	Inches
Gain in height per heifer[2]	2.9	2.5	.4
Gain in heart girth per heifer	5.3	6.2	.9

[1]Normal weight gain, 86.4 pounds.
[2]Normal height gain, 1.46 inches.

Three years' studies have shown that a high quality of hay may be obtained by completing the curing in the barn after partially curing in the field. Results of feeding trials are shown in table 15.

Other studies have been made at the West Tennessee Experiment Station, Jackson, and the Middle Tennessee Experiment Station, Columbia, with Jersey heifers. In both cases the cattle ate the barn-dried hay satisfactorily, but showed no significant difference in rate of growth as compared with heifers fed similar hay, field-cured under good conditions. No data are available on the feeding of barn-cured hay to cows, although it has been fed to cows with good results. No data are available as to the comparative value of barn-cured hay and hay damaged in the field by rain, but casual observations indicate a decided difference. In one case a field of red clover hay was cut in the forenoon for field-curing. About noon there was a forecast of rain. It was possible to get 17 loads into the barn. Two loads were out in the rain during the night; this hay could not be stored for two weeks, and was badly damaged. The hay in the barn was satisfactorily dried during this same period; was exceptionally good hay, and was fed to cows. Soybean hay has been satisfactorily cured in the barn at The University of Tennessee and on Lashbrooke farm, near Knoxville. Hay has also been cured in the barn and fed to cattle on the farms of Paul Jackson, at Maryville, and John Blake, at Straw-

[5]L. A. Moore, Mich. Agr. Exp. Sta.
[6]G. A. Shuey, Tenn. Agr. Exp. Sta.

berry Plains. Correspondence indicates that farms in many states, as well as the Experiment Stations in Illinois and Virginia, are using this system of curing hay.

SUMMARY

1. Green alfalfa hay may be satisfactorily dried in the barn by a system that forces air through the hay.

2. Alfalfa hay cured in the barn by this method is superior to field-cured hay, in color, grade, and amount of protein.

3. The system may be adapted for use in barns on individual farms.

4. Its main value is that it reduces shattering and danger of damage by rain.

5. Cost of operation was less than one dollar per ton of dried hay.

6. Early experimental work and plans for development of this system of hay-drying are reported in Tennessee Agricultural Experiment Station Bulletin 170: "Drying Hay in the Barn and Testing Its Feeding Value."

PROVED-DAIRY-SIRE PROJECT

C. E. Wylie and S. A. Hinton

The use of good proved sires is recognized as one of the most important factors in dairy-herd improvement. Formerly a few selected daughters of a bull were tested for production and the results accepted as a measure of the breeding value of the sire. In more recent years it has been found necessary to test all daughters of a bull for production and compare their records with similar records made by their dams. An analysis of these records more nearly measures the bull's value as a sire of high-producing daughters and of sons capable of siring high-producing cows. A project for the study of this question was started at The University of Tennessee in 1927, in cooperation with the U. S. Bureau of Dairy Industry.

HOLSTEIN SIRES

The Holstein proved-sire project was begun in July, 1927, when the University obtained the use of the Holstein bull Sir Colantha Ormsby Veeman from the Bureau of Dairy Industry herd at Beltsville, Maryland. This project has been in continuous progress since that time.

Fourteen daughters of Sir Colantha Ormsby Veeman reached maturity and were tested for milk and butterfat production in the University herd at Knoxville. These daughters have an average production of 13,726 pounds of milk and 503.9 pounds of butterfat. The dams of all these daughters were tested, and produced an average of

16,726 pounds of milk and 560.1 pounds of butterfat. All records were corrected to maturity. The daughters of Sir Colantha Ormsby Veeman showed an average decrease of 3000 pounds of milk and 56.2 pounds of butterfat as compared with their dams (table 16).

TABLE 16—*Sir Colantha Ormsby Veeman* 356098—*record of fourteen pairs of dams and daughters.*

Dams				Daughters			
Animal No.	Milk	Fat		Animal No.	Milk	Fat	
	Pounds	Percent	Pounds		Pounds	Percent	Pounds
55	16013	3.2	517.1	253	14079	3.6	507.1
117	13715	3.2	493.0	236	14368	3.3	479.8
115	16275	3.2	526.2	238	12562	3.5	445.3
117	13715	3.6	493.0	258	11074	3.5	385.6
107	22108	3.2	707.3	231	10498	3.6	378.5
102	14693	3.2	471.8	240	14051	3.8	532.1
102	14693	3.2	471.8	249	15202	3.7	564.1
102	14693	3.2	471.8	259	13642	3.5	473.3
97	24160	3.5	820.2	230	21006	3.9	822.9
97	24160	3.5	820.2	244	18560	3.7	684.8
97	24160	3.5	820.2	254	6554	4.0	376.7
117	13715	3.6	493.0	281	19629	3.6	698.1
239	10528	3.2	335.6	282	10412	3.6	371.9
72	11542	3.5	400.4	239	10528	3.2	335.6
14-pairs Av.	16726	3.35	560.1		13726	3.67	503.9

Decrease: Milk 3000 pounds; fat 56.2 pounds.

The Holstein bull Sir Colantha Barb Hero was secured from the Bureau of Dairy Industry in September 1933 (figure 13). This bull

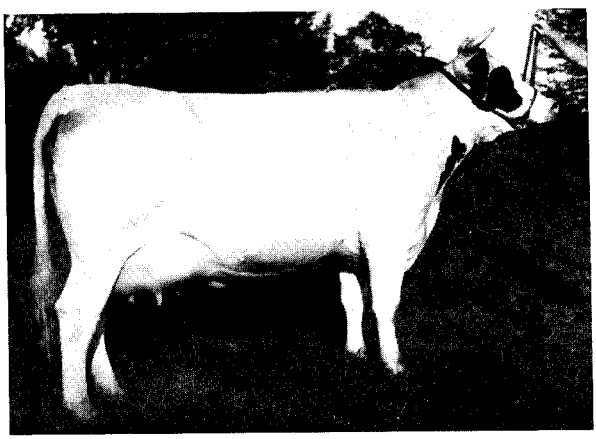

Fig. 13—U. T. Hero May, a daughter of Sir Colantha Barb Hero
Record: 18,814 pounds milk, 726 pounds fat, in 365 days, at 2 years of age.

now has 8 daughters that have completed records in the University herd. These daughters average 19288 pounds of milk and 687.5

TABLE 17—*Sir Colantha Barb Hero* 482861—*record of eight pairs of dams and daughters.*

Dams				Daughters			
Animal No.	Milk	Fat		Animal No.	Milk	Fat	
	Pounds	Percent	Pounds		Pounds	Percent	Pounds
105	287	3.6	468.9	13159	12265	3.7	455.0
97	293	3.5	820.2	24160	20337	3.6	750.2
107	294	3.2	707.3	22108	22400	3.6	813.1
282	302	3.6	371.9	10412	19674	3.7	688.5
245	303	4.0	624.5	15512	18630	3.6	674.2
253	308	3.6	507.1	14079	22952	3.5	803.5
107	310	3.2	707.3	22108	17574	3.6	632.9
105	312	3.6	468.9	13159	20471	3.3	682.7
8-pairs Av.	16837	3.48	584.5		19228	3.58	687.5

Increase: Milk 2391 pounds; fat 103 pounds.

pounds of butterfat (figure 14). Dams of these daughters average 16837 pounds of milk and 584.5 pounds of butterfat, an average increase for the daughters of 2391 pounds of milk and 103 pounds of butterfat (table 17).

Continuing this project, the University has used a bull of its own

Fig. 14—Daughters of proved Holstein sires at University of Tennessee. Left to right: Daughter of North Star Nona Homestead and three daughters of Sir Colantha Barb Hero.

breeding, U. T. North Star Ormsby. Twelve daughters of this bull are now in the herd and will be tested as they freshen. Following U. T. North Star Ormsby, the University secured in August, 1939, the bull Man-O-War Posch Tritomia Lad from the Maytag Holstein Farms in Iowa. The first calves of this bull arrived in September, 1940.

JERSEY SIRES

In 1931 The University of Tennessee secured the Jersey bull Tiddledywink Fauvic Actor from the U. S. Bureau of Dairy Industry.

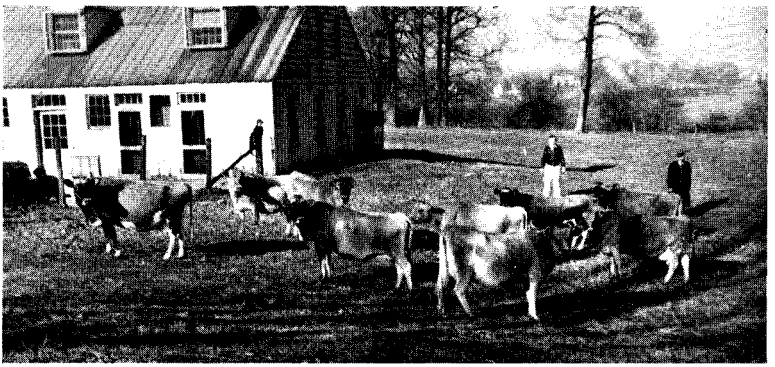

Fig. 15—Nine daughters of Tiddledywink Fauvic Actor.

TABLE 18—*Tiddledywink Fauvic Actor* 288048—*record of ten dams and daughters.*

Dams				Daughters			
Animal No.	Milk	Fat		Animal No.	Milk	Fat	
	Pounds	Percent	Pounds		Pounds	Percent	Pounds
211	7358	4.95	364.23	T30	10692	4.84	516.96
195	6931	4.69	324.92	T22	15409	4.66	718.32
210	12576	5.25	659.99	T 9	9213	4.43	408.41
210	12576	5.25	659.99	T33	15767	4.43	698.50
210	12576	5.25	659.99	T49	15282	5.17	789.46
11	10921	4.88	532.95	T12	15141	5.15	780.10
11	10921	4.88	532.95	T38	14940	4.92	734.63
34	6914	6.18	427.60	T32	15163	5.73	868.64
T13	.....	.....	.....	T45	12130	5.36	650.39
218	7250	5.49	398.01	T36	13673	5.73	783.25
153	6637	6.40	424.73	T14	13755	5.14	706.96
62D	.....	.....	.....	T63	15185	4.70	713.39
Average	9466	5.16	498.53		13863	5.03	697.42
10-pairs Av.	9466	5.16	498.53		13903	5.03	700.52

Increase: Milk 4437 pounds; fat 201.99 pounds.

Twelve daughters of this bull have been tested for milk and butterfat production and have mature-equivalent averages of 13863 pounds of milk and 697.5 pounds of butterfat. Ten are out of tested dams. These daughters average 13903 pounds of milk and 700.5 pounds of butterfat. Their dams average 9466 pounds of milk and 498.5 pounds of butterfat, showing an increase of 4437 pounds of milk and 202 pounds of butterfat (table 18).

Volunteer's Baron was secured from the estate of Mr. Frank Carpenter, to follow Tiddledywink Fauvic Actor as herd sire at the University. This bull now has 10 tested daughters that average

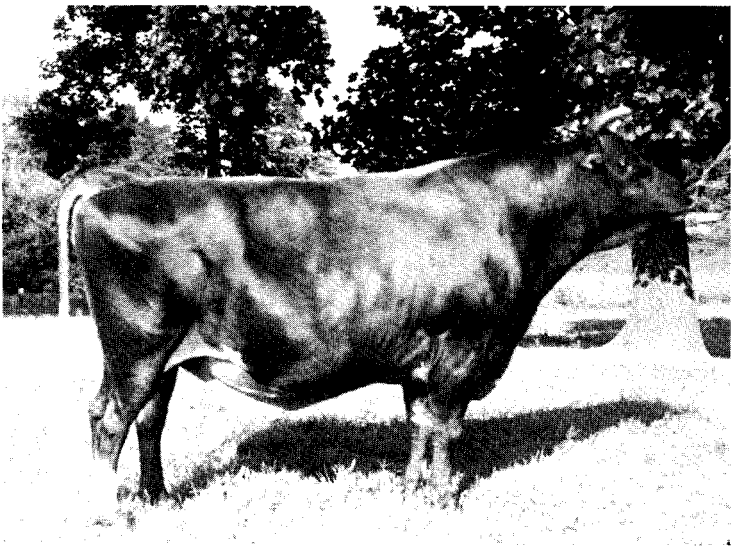

Fig. 16—Volunteer's Baron.

13028 pounds of milk and 706.05 pounds of butterfat. Eight of these daughters from tested dams average 12904 pounds of milk and 701.19 pounds of butterfat. Their dams average 12933 pounds of milk and 645.16 pounds of butterfat, showing an average decrease of 29 pounds of milk but an increase of 56 pounds of butterfat (table 19). This bull is still in active service (figure 16).

This project is being continued, with the bull Bet's Afterglow Observer, loaned by the Shelby County Penal Farm, beginning in March 1939. Daughters of this bull are to be tested as they come into production.

Jersey and Holstein bulls, sons of the above bulls, are being proved in a number of herds in Tennessee and other states. Recently

TABLE 19—*Volunteer's Baron* 286155—*record of eight dams and daughters.*

Dams				Daughters			
Animal No.	Milk	Fat		Animal No.	Milk	Fat	
	Pounds	Percent	Pounds		Pounds	Percent	Pounds
T14	13755	5.14	706.96	T51	13956	6.25	872.45
T36	13672	5.73	783.25	T54	10318	6.52	672.22
T30	10692	4.84	516.97	T56	14502	5.44	788.21
T22	15409	4.66	718.32	T57	13602	5.73	779.61
T39				T58	11575	6.25	723.16
T 9	9213	4.43	408.41	T62	10460	5.73	600.40
T31				T64	15465	4.70	727.12
T22	15409	4.66	718.32	T68	16026	4.48	717.25
T48	11012	5.80	639.16	T70	12388	5.21	645.22
T50	14304	4.68	669.92	T73	11984	4.46	534.16
Average	12933	4.98	645.16		13028	5.42	706.05
8-pairs Av.	12933	4.98	645.16		12904	5.43	701.19

Decrease: Milk 29 pounds; increase: fat 56.03 pounds.

daughters of the Holstein bull U. T. Ormsby Colantha De Kol 674230, tested in the herds of Knapp Farm, Nashville, and B. R. Harr, Bristol, showed an average increase of 1320 pounds of milk and 51 pounds of fat as compared with their dams. Sons of the above bulls, 37 Holsteins and 33 Jerseys, are being used, or have been used, in herds in Tennessee and other states.

MILK-FLAVOR STUDY

H. B. Henderson, Thos. B. Harrison, S. A. Hinton, and C. E. Wylie

FLAVOR SCORE OF MILK FROM INDIVIDUAL COWS

Milk from 4 groups of cows in the University herd has been examined for flavor score at weekly intervals. Three of these groups were used in connection with silage-feeding experiments, while the fourth group was composed of cows in the herd on official test. Results last year showed practically no difference in the average score of milk for the 3 groups receiving alfalfa silage, corn silage, and sericea silage. Flavor scores this year, however, show a distinct variation. Average scores (standard milk score card) on the milk from the 4 groups is as follows:

Group	Raw milk score	Pasteurized milk score
Alfalfa silage	20.72	22.11
Corn silage	20.44	21.50
Sericea silage	21.55	22.55
Test cows	21.22	22.16

The sericea group had about one point higher average for raw milk than either of the other silage groups. In view of the fact that these groups were handled as nearly alike as possible, this is a signif-

icant difference. The test-cow group, which had a flavor score only slightly lower than that of the sericea group, was not always fed silage before milking as were the other groups. The pasteurized milk also from the sericea group was higher than that from any of the other groups.

FLAVOR SCORE OF MILK FROM U. T. PATRONS

Samples of milk for flavor determination have been taken from patrons shipping milk to the University Creamery at weekly intervals for over one year. Some patrons consistently ship milk with a good flavor, while milk from other farms has a strong feed flavor. There is some variation from week to week in all cases. This variation usually is not great, although the flavor of milk shipped by some patrons does fluctuate greatly from week to week.

Only 3 patrons regularly ship milk that is sufficiently susceptible to the development of oxidized flavor to be seriously objectionable. A special study is being conducted on the milk from one of these patrons. If possible this study will be extended to include milk from other patrons.

OXIDIZED FLAVOR IN MILK

INDIVIDUAL COWS

During the winter of 1939-40 it was noted that the cows in the University herd on official test invariably produced milk that developed strong oxidized flavor upon the addition of copper at the rate of 2½ parts per million. Milk from the other cows in the herd developed varying degrees of the flavor, but none was as seriously susceptible as that from the test-cow group. During the spring and summer, when the cows were on pasture, there was very little, if any, reduction in the intensity of the development of this flavor. Practically all cows on official test have been producing milk during the fall and winter susceptible to the development of oxidized flavor, the general trend being the same as last year. Although there is some variation in the degree of concentration of oxidized flavor in milk from different cows every cow in the group produces milk that would be considered seriously objectionable from this standpoint. A small percentage of cows not in the test group are producing milk very susceptible to the development of this flavor.

COMMERCIALLY PASTEURIZED

Samples of pasteurized milk from all plants selling in Knoxville have been collected at regular intervals. The data obtained show that a large percentage of the pasteurized milk sold in Knoxville has some oxidized flavor, and about one-fourth of the plants are producing milk that develops this flavor to such an extent that it would be con-

sidered seriously objectionable. About one-half of the plants are producing milk that develops a slight oxidized flavor, and about one-fourth are producing milk that is consistently free from it.

EXPERIMENTAL LABORATORY PASTEURIZER

Because an ever-increasing percentage of the milk consumed in the cities is pasteurized, there is definite concern regarding the flavor of pasteurized as well as raw milk. When the study of milk flavors was started, in 1939, the need was evidenced for a small pasteurizer in which samples of milk could be pasteurized under conditions that would as nearly as possible simulate those encountered in commercial pasteurization. Through a cooperative agreement between The University of Tennessee and the Tennessee Valley Authority, plans for such a pasteurizer were drawn up and construction started by Mr. H. A. Arnold, of the Agricultural Engineering Department, in the spring of 1940. It was completed late in the summer, and has been used during the fall and winter. Its use thus far has been in connection with the flavor studies of the silage-feeding experiment.

This laboratory pasteurizer was built on the style of the commercial spray-type vats (figure 17). It has six separate compart-

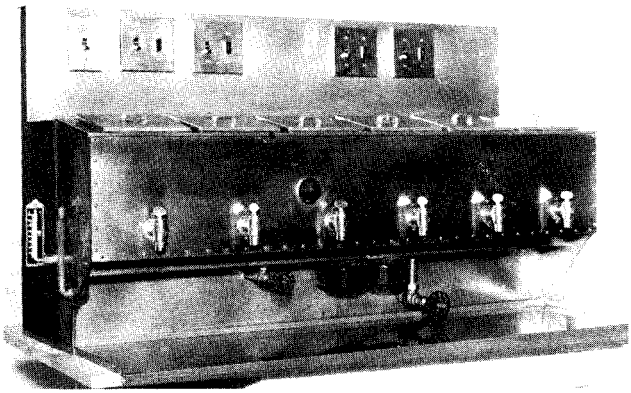

Fig. 17—Laboratory pasteurizer—front view.

ments, or vats, so that six 2-quart samples of milk can be pasteurized at the same time under identical conditions. The milk is heated by a film of hot water flowing down the sides of the vats. This water is electrically heated in a compartment at the bottom of the pasteurizer, and is circulated by a centrifugal pump through specially perforated pipes so arranged as to direct a spray of water against the sides of the vats. The water then runs back to the bottom of the pasteurizer, where it is reheated, to be circulated again through the system (figure 18). The temperatures of both water and milk are thermostatically

controlled. The pasteurizer is of stainless-steel construction throughout.

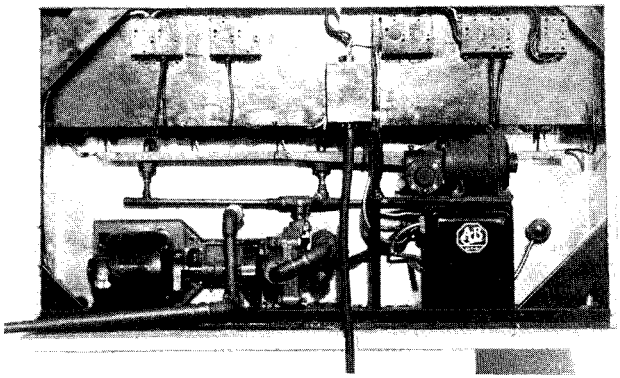

Fig. 18—Laboratory pasteurizer—rear view.

Results to date on samples of milk pasteurized in this unit show that usually a considerable improvement in the flavor of the milk results from pasteurization. In every case an increase in the flavor score of the pasteurized over the raw milk was noted, and in most cases milk with a very strong silage flavor showed an increase of from 1 to 2½ points. An average of 32 trials run in connection with the silage-feeding experiment and the milk-flavor study shows a score for raw milk of 20.93; for pasteurized milk, 22.09—an increase of 1.13 points due to pasteurizing.

Pasteurization improved the flavor of the milk by decreasing the intensity of the feed or silage flavor, and not by giving the milk a cooked flavor that covered up other flavors. In only a very few cases was the term "cooked" used as a descriptive criticism of the flavor of the pasteurized milk. In criticisms of commercially pasteurized milk this term is one of the most frequently used.

So far as the production of a cooked flavor in the milk is concerned, it would appear that the pasteurizer is satisfactory.

POULTRY HUSBANDRY

Jesse E. Parker and B. J. McSpadden

PASTURES FOR GROWING PULLETS

During the spring of 1940, four groups of Barred Plymouth Rock pullets were reared on ranges with 3 types of pasture crops, as follows:

TABLE 20—*Growth and feed consumption of pullets, 1940.*

Lot	Kind of pasture on range	Average body weights of pullets			Feed consumed per pullet			Feed to produce pound of gain	Feed cost[1] to 24 weeks	
		1 day	12 weeks	24 weeks	Mash	Grain	Total		Pullet	Pound of gain
		Pounds	Pounds	Pounds	Pounds	Pounds	Pounds	Pounds	Cents	Cents
1	None—bare range	0.085	2.63	4.67	18.1	7.6	25.7	5.6	55.2	12.1
2	Spring oats	0.086	2.59	4.84	14.7	8.9	23.6	5.0	49.0	10.3
3	Italian ryegrass and lespedeza	0.085	2.63	4.97	16.2	9.5	25.7	5.3	53.7	11.0
4	Alfalfa	0.085	2.67	5.17	15.4	10.1	25.5	5.0	52.6	10.4

[1]Calculated on a basis of $2.40 per cwt. mash and $1.55 per cwt. grain.

Lot 1—No crop planted—yard kept bare throughout growing period.

Lot 2—Spring oats.

Lot 3—Mixture of Italian ryegrass, Korean lespedeza, and Kobe lespedeza.

Lot 4—Alfalfa.

All pasture crops were seeded March 17.

In 10 x 12-ft. colony brooder houses 125 unsexed chicks were started March 13. The chicks were not permitted outside the brooder houses until 6 weeks of age. At 8 weeks the cockerels were removed and marketed as broilers. An adequate all-mesh chick ration was fed to the age of 8 weeks and thereafter supplemented with yellow corn ad libitum. Records were kept by 4-weeks periods on body weights and feed consumption.

During the early weeks an abundance of succulent green feed was supplied by the various crops. By June 1 the oats, in lot 2, had headed; hence, their continued value as green feed was questionable. The ryegrass-lespedeza mixture, in lot 3, supplied an abundance of succulent green feed until late September. The spring-seeded alfalfa, in lot 4, although slow in getting established, furnished an abundance of succulent green feed to late October. The pullets were removed from all lots October 23, at the age of 32 weeks.

Growth data were discontinued when the pullets reached the age of 24 weeks. Pullets on the bare range made a slower growth than those on the pasture crops. The most rapid growth was made by the pullets on alfalfa pasture. Pullets on the ryegrass-lespedeza pasture made a more rapid growth than those on oats. Table 20 compares the body weights of the 4 groups at the ages of 1 day, 12 weeks, and 24 weeks, and summarizes the feed consumption, feed cost, and efficiency of feed utilization.

Table 21 shows, in percentages, the mortality, pullets culled, and pullets housed. The desirability of a supply of succulent green feed is indicated by the figures shown for lots 2, 3, and 4. Culling was done on the basis of vigor and vitality, and no attempt was made to select on the basis of probable egg production. The alfalfa pasture yielded the highest number of pullets to be housed and the lowest

TABLE 21—*Mortality, pullets culled, and pullets housed,* 1940.

Lot	Kind of pasture on range	Pullets at 4 weeks of age	Mortality 4 to 32 weeks	Pullets culled at 32 weeks	Pullets put in the laying house at 32 weeks	
		Number	Percent	Percent	Number	Percent[1]
1	None—bare range	67	19.4	13.0	47	70.1
2	Spring oats	56	5.4	5.9	50	89.3
3	Italian rye grass and lespedeza	68	10.3	5.0	58	85.3
4	Alfalfa	69	4.3	1.6	65	94.2

[1]Percentage of those alive at 4 weeks.

mortality. The results were similar from the other pastures. The bare lot yielded the lowest percentage of pullets housed and the highest percentage of mortality.

Considering the results of one trial, both from the agronomic and poultry husbandry viewpoints, it would seem that alfalfa, spring oats, or a mixture of Italian ryegrass and lespedeza, provides suitable succulent green feed for growing chickens.

This experiment will be repeated in 1941.

FERTILITY STUDIES

Infertility in hen's eggs results in a great economic loss to poultry breeders and commercial hatcherymen. During the past year, investigations on several phases of the problem have been started.

Nutrition and Fertility in Male Fowls

A project for the study of the influence of nutritional deficiency on fertility in male fowls has been in progress for a year. Three groups of Single Comb White Leghorn cockerels received the following diets, all in mash form:

Lot 1—Control—adequate diet ad libitum.

Lot 2—Restricted diet—a ration identical in composition with that of lot 1, the amount fed being about 60 percent that consumed by the control group.

Lot 3—Vitamin A-deficient diet.

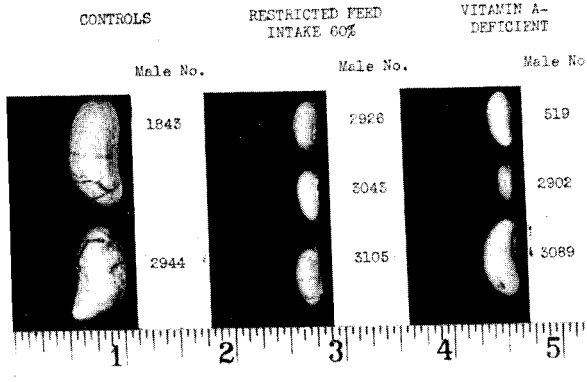

Fig. 19—Effect of vitamin A deficiency and inanition of testis size in fowls. Cockerels on experimental diets seven months.

The results from one trial, started April 6 and completed in November, give the following indications:

1. In fertilizing capacity[1], the males in lots 2 and 3 approached

[1]Fertility of the males was determined on the basis of the percentage of fertile eggs produced by hens which had been artificially inseminated with .1 cc. of semen from each male.

zero after being fed the experimental diets for 5 and 6 months, respectively; whereas, with the controls a fair level of fertility was obtained throughout the experiment.

2. The number of spermatozoa per ejaculate produced by the males on the restricted diet fell below that of the control males within from 1 to 2 months. The males on the vitamin A-deficient ration did not have a noticeable decrease in spermatozoa production until they had been on the ration from 5 to 6 months.

3. Mortality of males on both vitamin A-deficient and restricted diets exceeded that of the control group.

4. Testes weights of males in the control group exceeded those of males in the experimental groups.

5. Combs and wattles of males on restricted ration showed considerable atrophy.

These investigations are to be repeated during 1941.

Other Studies on Fertility

During the past year, records have been maintained on the percentage of fertile eggs produced by hens in flock mating and by hens fertilized by artificial insemination. Fertility obtained from artificial matings compared favorably with that observed in flock matings. In experiments with Single Comb White Leghorn pullets during March and April, it was observed that on the first day following insemination no fertile eggs were produced, but from the second to the eleventh day, inclusive, high percentages of the eggs were fertile. There was a gradual decrease in percentages of fertile eggs from the twelfth to the twenty-first day. Doses of .1 cc. of undiluted semen resulted in satisfactory percentages of fertile eggs.

Green Feed Supplements in the Chick Ration

In cooperation with Mr. E. K. Weathers, of the General Chemistry Department, an experiment was conducted to determine the nutritional values of meals made from leaves of certain leguminous plants. Meals were prepared from leaves of alfalfa, sericea, and Korean lespedeza. Four lots of Barred Plymouth Rock chicks were used. Each group

TABLE 22—*Chemical composition of diets*

Constituents	Lot 1 Basal diet plus alfalfa	Lot 2 Basal diet plus Korean	Lot 3 Basal diet plus sericea	Lot 4 Basal diet only (control)
	Percent	Percent	Percent	Percent
Protein (N x 6.25)	20.75	20.56	20.69	20.56
N-free extract	52.58	50.93	49.24	51.69
CaO	2.27	2.30	2.52	2.53
P_2O_5	2.54	2.57	2.70	2.82
Mn_3O_4	.0051	.0049	.0051	.0034

TABLE 23—*Influence of leaf meals on growth, feathering, and mortality of Barred Plymouth Rock chicks,* 1940-41.

Lot	Leaf meal added to basal ration	No. chicks	Average body weights			Chicks with different types of feathering at 8 weeks			Mortality to 12 weeks
			4 weeks	8 weeks	12 weeks	Rapid	Medium	Slow	
			Pounds	Pounds	Pounds	Percent	Percent	Percent	Percent
1	Alfalfa leaf meal	46	.51	1.51	2.81	37.5	57.5	5.0	15.2
2	Korean lespedeza	46	.52	1.54	2.85	34.1	61.4	4.5	4.3
3	Sericea lespedeza	46	.47	1.49	2.84	21.4	71.4	7.2	8.7
4	None—basal only	47	.46	1.30	2.65	2.4	78.1	19.5	12.8

was brooded in a separate colony house under an electric brooder. The basal diet was composed of the following ingredients:

	Percent
Ground yellow corn	45
Wheat bran	15
Wheat red-dog flour	15
Meat meal (55% protein)	19
Salt	1

Additions were made to these diets in the several lots as follows: Lot 1, 5 percent alfalfa leaf meal; lot 2, 5 percent Korean lespedeza leaf meal; lot 3, 5 percent sericea leaf meal; and lot 4 (control), 5 percent ground yellow corn instead of the green-feed supplement. In all lots, 298 chick units of vitamin D per pound of feed were supplied by Delsterol. The chemical composition of the diets is shown in table 22.

Data on the rate of growth, feathering, and mortality are presented in table 23. The results indicate that the addition of 5 percent of either of the 3 leaf meals is conducive to rapid body growth and early feathering.

PHOSPHATE NUTRITION STUDIES WITH RATS AND CALVES

Dorothy E. Williams and Elise Morrell

Evidence for a difference in the availability of phosphorus in low-phosphorus versus high-phosphorus hay of the same type has been found with white rats used as pilot animals. Extension of this problem with calves as the experimental animals has given essential substantiation of the results. As with rats, the nutritive quality of rations and food consumption of comparable animals were kept as nearly uniform as possible. In the control diet, 2/3 of the phosphorus was supplied from sources known to be readily available. In the hay diets, ½ the phosphorus was supplied from a large amount of low-phosphorus hay in one case and from a small amount of high-phosphorus hay in the other. For all three rations the total amount of phosphorus was the same—7.5 grams of phosphorus daily, which is approximately minimal for normal growth.

The animals on the low-phosphorus hay rations were less thrifty than the controls or the animals fed the high-phosphorus hay, according to various criteria for growth. During an experimental period of 224 days, average gains in growth, expressed by body weight in pounds, height at withers, and heart girth in inches, respectively, were, for control calves, 180, 6.1, and 7.5; for calves on the low-phosphorus red clover, 59, 3.1, and 2.3; and for calves on high-phosphorus red clover, 173, 5.1, and 6.7. These results may be taken as indicating that the phosphorus in the low-phosphorus hay is less available to the animal than that in the high-phosphorus hay. It is recognized that there may be some difference other than phosphorus content in quality of the hays, not brought out by routine analyses, that may be

responsible in part for the difference in behavior of the animals.

Another feeding experiment with calves was set up to compare the feeding value of a low-phosphorus versus a high-phosphorus red clover hay when they were fed in equal amounts as part of a simple wintering ration consisting of ¾ clover hay and ¼ ground corn, plus salt and cod liver oil. The only difference in the two rations was the red clover, which for lot 1 was a hay containing 0.12 percent phosphorus and for lot 2 was one containing 0.31 percent phosphorus. The total daily amounts of phosphorus supplied lot 1 and lot 2, respectively, were 6 grams and 11 grams.

The animals on the low-phosphorus hay ration were less thrifty than those on the high-phosphorus hay ration, according to various criteria for growth. During an experimental period of 224 days, average gains in growth, expressed by body weight in pounds, height at withers, and heart girth in inches, respectively, for the animals on the low-phosphorus hay ration, were 86, 3.5, and 3.2; and for those on the high-phosphorus ration, 125, 4.6, and 6.1.

Blood-phosphorus determinations were made on each animal every 28 days on a composite 3-day sample of whole blood. At the beginning of the experiment the inorganic blood phosphorus for both groups was approximately the same and somewhat below average. During the next two 28-day periods the average blood-phosphorus level rose to normal for those animals receiving the high-phosphorus hay and remained there throughout the period; for the calves receiving the low-phosphorus hay the average blood-phosphorus level rose slightly at first and remained at a subnormal level until near the end of the period, when it again began to rise to a nearly normal level.

It is concluded that the feeding value to calves of a low-phosphorus red clover hay is distinctly less than that of a high-phosphorus red clover hay of approximately the same grade and general appearance.

Exploratory work is being carried on with the same wintering ration of red clover hay and corn meal, with modifications made by including either phosphorus supplements or protein supplements, or both, in the original rations.

More work has also been done with rats in an attempt to arrive at an explanation for the difference in behavior of both rats and calves on rations containing hays of low-phosphorus content on the one hand and of a high-phosphorus content on the other, whether the hays in comparable rations are fed in the same amounts or in the amounts to furnish equal quantities of phosphorus at a minimal level.

GENERAL CHEMISTRY

G. A. Shuey

SILAGE

It is well known that the most important feed for cattle is provided by hay crops. These crops, which are enormous the country

over, formerly were stored, for the most part, in the conventional haymow and haystack, and it was not until comparatively recent years that other methods of conserving them were considered.

Losses in curing hay crops and storing them in the dried form have been somewhat discouraging to farmers. In seasons of heavy rainfall it is difficult, if not impossible, to cure them properly. Undue exposure to rain, wind, air, and bright sunshine produce physical and biochemical changes in hay crops that impair their value as feed. The silo is a great help to the farmer in conserving the whole of such crops with their fullest nutritive qualities, provided proper precautionary measures are observed.

By virtue of the fact that corn and sorghum crops contain appreciable amounts of fermentable carbohydrates, such as starch and sugars, and are low in protein, their nutritive qualities are easily preserved in the silo. Hays from legumes are high in protein and calcium and low in fermentable carbohydrates. Consequently, their preservation as silage presents more of a problem.

Our experiments have shown that there are several ways of making good silage out of grasses, legumes, and mixtures of the two crops. In all cases the crops must be cut fine and packed tight in the silo in order to eliminate air as much as possible. Fine-cut plant material continues to respire for a time after it is placed in the silo. That is to say, it absorbs oxygen from the air and produces carbon dioxide gas. Within a few hours, fermentation begins, which also uses oxygen and produces carbon dioxide gas. The net result is the replacement of the air within the ensiled mass with carbon dioxide gas, which in itself serves as a preservative. Furthermore, if air is eliminated, mold growth will be reduced to the minimum, since the development of molds is dependent upon oxygen. Consequently, it is important to cut fine and pack tight all crops going into a silo.

Studies of the value of molasses, orthophosphoric acid, molasses-orthophosphoric acid mixture, and propionic acid, in converting grasses and legumes into silage, have been continued. Eight silos were used, of 10-tons capacity each, located at the Tobacco Experiment Station at Greeneville. Four silos were filled with fine-cut alfalfa, and 4 with fine-cut sericea. Blackstrap molasses was applied at the rate of 60 pounds per ton to one silo each of alfalfa and sericea. Orthophosphoric acid was applied to one silo of alfalfa and to one silo of sericea, at the rate of 30 pounds of 50-percent acid per ton. Molasses-orthophosphoric acid mixture was applied to one silo each of alfalfa and sericea, at the rate of 40 pounds of molasses and 15 pounds of 50-percent acid per ton. One silo of each crop received no treatment. At the time of ensiling, the average moisture content of the alfalfa was 70.14 percent, and of the sericea, 64.60 percent.

Beginning in November 1940, and continuing through January

1941, groups of steers were fed alfalfa and sericea silage made with the several treatments. Animals receiving alfalfa silage showed a slightly higher average daily gain in weight than those fed on sericea silage similarly preserved. Better gains were made by animals receiving alfalfa silage preserved with orthophosphoric acid, and with molasses-orthophosphoric acid mixture, than animals fed the same crop preserved with molasses and no treatment. Animals fed on sericea silage preserved with molasses, molasses-orthophosphoric acid mixture, and no treatment, showed better weight gains than the group receiving the same silage treated with orthophosphoric acid alone. The group of steers receiving sericea silage preserved with orthophosphoric acid showed an average daily weight gain of about one-half that of the other groups. Animals receiving sericea silage preserved with molasses-orthophosphoric acid mixture showed fair weight gains, but still somewhat less than those groups which were fed sericea silage preserved with molasses alone, and no treatment. Sericea silage preserved with mineral acids shows, by analysis, a relatively high content of water-soluble tannin.

In a further study of the value of molasses-orthophosphoric acid mixture in the making of legume silage, two silos of 10-tons capacity each, located at the Cherokee Farm, were used.[8] One silo was filled with alfalfa and the other with sericea. Both crops were treated with molasses-orthophosphoric acid mixture at the rate of 60 pounds of molasses and 10 pounds of 75-percent acid. Both produced silage of excellent quality. The silage made from the two crops was eaten equally well by dairy cattle. Feeding and analytical data are being compiled.

Alfalfa and sericea crops were ensiled in small experimental containers, propionic acid being added as preservative at the rate of 4 pounds per ton of green crop. Silage of good quality resulted. It is claimed that propionic acid will retard the growth of molds in silage. Silage-making studies, using propionic acid as preservative, will be conducted on a more extensive and practical scale next year.

It may be concluded that molasses, orthophosphoric acid, and molasses-orthophosphoric acid mixture provide three effective aids in preserving grass and legume crops as silage. Orthophosphoric and other mineral acids, however, should not be used alone in making silage of sericea until we have more definite knowledge that they do not impair the quality.

Regardless of added preservative, silage quality is governed largely by the condition of the crop, stage of maturity, and moisture content at the time of ensiling. As a general rule, if palatable and nutritious grasses or legumes, having a dry-matter content of 32 to 40 percent, are cut fine, mixed well with the proper amount of preserv-

[8]In cooperation with C. E. Wylie and S. A. Hinton, Dairy Department, University of Tennessee.

ing material, and packed tight in an air-tight silo, nutritious silage of good flavor will result.

MOVED TO NEW QUARTERS

In December the General Chemistry Department occupied new quarters in the recently completed Agricultural Engineering Building, located at the University Farm.

Fig. 20—General-chemistry laboratory.

Laboratories, offices, and a storage room were built and equipped according to carefully drawn plans. Laboratory furniture, plumbing, and electrical outlets supplying both 110 and 220 volts are arranged for convenience and efficiency. One large room is equipped for general analytical work. One smaller room is equipped for preparing and storing samples of materials. A third room is being equipped for experimental processing of foods and other materials.

SORGHUM SIRUP

Laboratory work on sorghum juices and sirup was continued. Numerous samples of sorghum sirup, received from different processors throughout Tennessee and several neighboring states, were examined and a number analyzed for sugars and ash content. No field work was done on this project during the year, except in an advisory way.

Experimental work on sorghum sirup over a period of 5 years has demonstrated that uniform sirup of excellent quality can be produced in quantity by the use of rather inexpensive equipment. A detailed description of the process is being prepared for publication.

A group of business men located in one of the better sorghum cane-growing areas of the State are making plans to manufacture sorghum sirup by our process in conjunction with their vegetable-canning operations.

In view of the inevitable shortage of sugars and other carbohydrate foods in the present emergency, it was believed that suggestions for the marketing of sorghum sirup would be timely and might be of pracical help to southern producers of sorghum sirup. Copies of the following suggested specifications for sorghum sirup were submitted to the chairman of the Provisions Committee, Federal Specifications Board, United States War Department:

Sirup, Sorghum (Sorgo).—Shall be a sound product and made by the evaporation of the juice of the sweet sorghum (sorgo) cane. Shall contain not more than 30 percent water and not more than 3.5 percent ash. Baumé test (Bureau of Standards Baumé scale for sugar solutions) not less than 37.56° at 20°C. Taste shall be mild and characteristic of sorghum. Color shall be light to medium-dark amber when viewed in a glass tube 7 millimeters in diameter, by transmitted

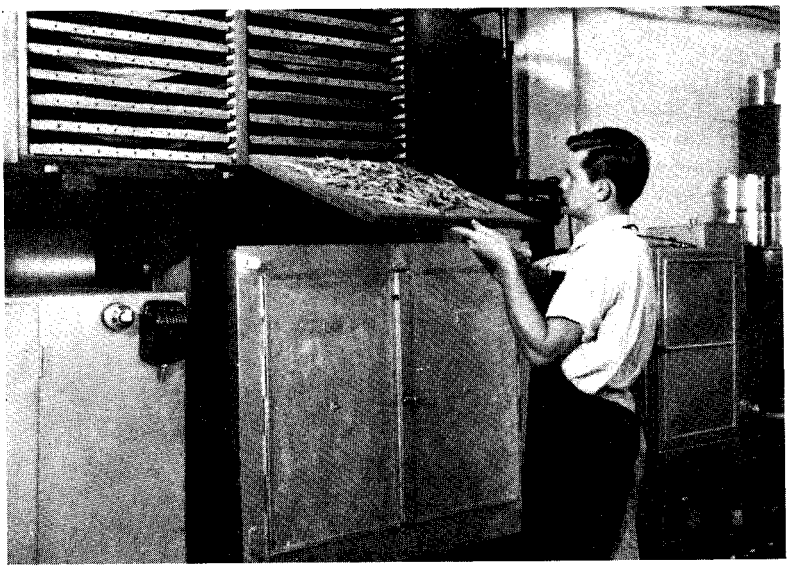

Fig. 21—Food-processing laboratory: Dehydration experiments on fruits and vegetables.

light. Part of the sucrose may be inverted by means of invertase or other suitable inverting agents.

Fig. 22—Food-processing laboratory: Preparation of juices and other products from fruits and vegetables.

SWEETPOTATO STUDIES

Small-scale experiments were conducted to determine optimum conditions for the conversion of starch, naturally present in sweetpotato, to soluble dextrins and maltose sugar. Studies were made also of the effects of different temperatures and humidities on the quality of desiccated product. Consideration was given to ways of preventing caking of pulverized desiccated sweetpotato product. A drier, with accessory equipment, is being installed in the new food-processing laboratory. Needless to say, desiccated sweetpotatoes and other dried fruits and vegetables, properly made, would provide concentrated articles of food that might prove very useful for the armed forces and hungry peoples abroad.

MISCELLANEOUS

Analytical and consulting service on a wide variety of subjects has been rendered to other Station departments, the Agricultural Extension Service, and several departments of the College of Agriculture. Help has been given farmers in the clarification and preservation of tomato and apple juices, and in the making of sorghum sirup.

Plans are being made to install equipment for experimental preservation of foods by freezing.

COOPERATIVE WORK WITH OTHER DEPARTMENTS

K. B. Sanders

In addition to work noted elsewhere in the Annual Report, miscellaneous chemical and other laboratory work has been done independently or in cooperation with other departments. Analyses have been made of a number of plant-food products for use with potted plants in the home or for the growth of plants in water culture without soil. Total solids in a sample of mineral water was determined for one of our farmers, and comparison made with normal potable waters. Analyses of fertilizers and soils and a comparison of several phosphate fertilizers as regards their relative effects on seedling emergence, have been made in cooperation with the Agronomy Department. Erosion-control experiments involving runoff plots have been continued in cooperation with the departments of Agronomy, Horticulture, and Agricultural Engineering.

PLANT COMPONENTS

E. K. Weathers

Continuing the project on plant components, the following samples were collected and analyzed: Tobacco, milk, red raspberries, strawberries, mixed hay, and leaves of sericea, Korean lespedeza, and alfalfa.

TOBACCO

The experiment concerning potash uptake by tobacco was continued at Knoxville and Greeneville. Samples of the tobacco grown at both Stations were taken for chemical analysis.

Data have been accumulating for several years and will be presented in detail later. Results to date show definitely that is is possible to increase the concentration of potash in tobacco leaves by fertilization. This higher concentration of potash has been associated also with increased yield. Results show, moreover, that the heaviest applications of fertilizer usually produce tobacco leaves with the greatest concentration of potash. There is an indication that potassium metaphosphate is a somewhat better source of patash than potassium chloride or potassium sulfate. It appears that manure in combination with the mineral fertilizers has a favorable influence on yield of leaves as well as the concentration of potash in the leaves.

These results furnish encouragement in the attempt to build up the concentration of potash in the leaf of burley tobacco and thus improve its quality.

CHEMICAL COMPOSITION OF LEAVES OF ALFALFA AND LESPEDEZAS[9]

Alfalfa, Korean lespedeza, and sericea were harvested the latter part of August from similar soil types at the Knoxville Station. Samples were placed in a large electric drying oven in green condition and dried, and afterward were ground and analyzed. The results are presented in table 24.

TABLE 24—*Chemical composition of leaves of alfalfa, Korean lespedeza, and sericea.*

Crop	Moisture	Ash	Protein (N x 6.25)	Crude fat	Crude fiber	N-free extract	CaO	P_2O_5	Mn_3O_4
	Percent	Percent	Percent	Percent	Percent	Percent	Percent	Percent	Percent
Alfalfa	12.00	10.26	20.81	3.80	14.15	38.98	4.06	.56	.013
Korean	11.95	5.67	19.06	4.50	20.95	37.87	1.71	.79	.020
Sericea	13.65	4.69	14.69	4.10	19.60	43.27	1.60	.38	.020

MILK

Milk samples were collected from 10 groups of cows, including part of the University herd, plus 2 samples from farmer herds. All groups in the University herd had received different diets. Corn, alfalfa, and sericea silages were included in the diets of 3 groups. The legume silage had been treated with phosphoric acid. The results showed a considerable variation (.082 to .112% P) in phosphorus content between the groups fed on different diets, but more samples will have to be studied before definite conclusions can be drawn as to the effect of various diets on the phosphorus content of the milk.

RED RASPBERRIES AND STRAWBERRIES[10]

Some of the most promising selections of new varieties of red raspberries and strawberries developed at this Station by the Horticulture Department were obtained for chemical analysis.

RED RASPBERRIES

Results show considerable variation in percentage of acid and of total solids. The percent of acid ranged from 1.42 for Latham[11] to 2.08 for X281, while the percentage of total solids ranged from 4.90 for X318 to 8.00 for X281. Latham had a percentage of 6.80.

Latham and X237 had the widest acid:total-solids ratio—1:4.80 and 1:4.46 respectively—and both varieties had a rather flat taste. This may indicate that a somewhat narrower acid:total-solids ratio may be associated with the most desirable flavor in the red raspberry.

[9]The leaves of each of these legumes were used in a poultry-feeding experiment to determine the relative value of each as a green-feed supplement. A detailed report on this experiment is presented in the poultry section of this report.

[10]Breeding work conducted by Horticulture Department.

[11]Latham was included for comparison, since it is the variety used mainly by growers.

STRAWBERRIES

The varieties of strawberries showed no significant difference in pH or total acid. There was a distinct variation, however, in the total-solids content, which showed a range from 6.65 percent for sample No. 148 to 8.05 percent for sample No. 865.

Table 25 shows no significant difference between the pH of the red raspberries and that of the strawberries. The red raspberries, however, had a considerably higher percentage of acid and a somewhat lower percentage of total solids. The red raspberries had an acid: total-solids ratio of 1:3.72, while the strawberries had 1:6.14.

TABLE 25.—*Constituents of red raspberries versus strawberries.*

Name	Samples analyzed	Juice	Acid (citric)	Total solids	Total acid: solids
	Number	pH	Percent	Percent	Ratio
Red raspberries	10	3.37	1.73	6.41	1:3.72
Strawberries	6	3.27	1.21	7.19	1:6.14

CHEMISTRY: SOILS AND FERTILIZERS

W. H. MacIntire and W. M. Shaw

CALCIUM AND MAGNESIUM STUDIES

The incidence and combinations of calcium and magnesium in the soils of humid regions are important considerations, because of the nutritive value of these elements and their ability to counteract the acidity, or sourness, that follows the depletion of base content to a low level. The degree of saturation with calcium and magnesium affects the general fertility level of a soil, in relation to the maintenance of a satisfactory supply of nitrogen, sulfur, phosphorus, and potassium.

Calcium and Magnesium Silication.—This project consists of a sustained lysimeter study of the performance of additions of 7 liming materials, oxides and carbonates of calcium and magnesium, and dolomite, at heavy rates to an acidic Cumberland clay loam alone and with a stratum of subsoil. The rate of reaction with the soil was ascertained in the early stages of the experiment by frequent determination of the residues of the respective carbonates. The solvent action of soil waters upon the different materials also was gauged by the annual rainwater leachings of calcium and magnesium, which vary according to the rainfall and its seasonal distribution. The total rainfall for the last annual period was 46.2 inches and the mean leachate volume from the 46 lysimeters was the equivalence of 22.8 inches.

It is safe to assume that the soils of this experiment now are saturated with either calcium or magnesium after 25 years' contact

with the several heavy calcic, magnesic, and dolomitic treatments. The loses of calcium and magnesium may be taken as representing the maximal solvent action of rainwater leachings upon similar soils saturated with calcium or magnesium and containing variant proportions of the respective additive liming materials. The losses of calcium from the calcic materials incorporated at the rates of 8 tons of CaO per acre were approximately 365 pounds, without any present effect attributable to the initial variation as to oxide and carbonate forms. The last annual outgo of calcium from the calcic carbonates was approximately the same for the 3 rates of 8, 32, and 100 tons of CaO-equivalence. The combined losses of calcium and magnesium from the additions of dolomitic limestone and from the additions of magnesite were appreciably greater than those from high-calcic limestone, and were considerably greater for the heavier rates of application. The oxide and precipitated carbonate of magnesium showed the greatest leachability and a definite effect for increases in rate of application. The last annual leachings of calcium + magnesium from the dolomite treatments were 358, 442, and 498 pounds for the respective 8-, 32-, and 100-ton CaO-equivalences, whereas the corresponding losses from equivalent treatments of magnesite were 374, 522, and 588 pounds. The losses from the comparable hydrated magnesium carbonate treatments were 319, 563, and 1754 pounds, respectively. The present relatively low value for Ca + Mg outgo from the moderate addition of magnesium carbonate is attributable to the substantial depletion of the magnesium of this treatment during the earlier stages of the experiment, whereas the large residues of the heavier treatments still yield leachings rich in magnesium.

The losses of nitrogen and sulfates from these lysimeters afford and interesting side light as to the acid-base combinations in which calcium and magnesium are leached from these soils. The nitrogen losses range from 8 to 16 pounds and are not greatly affected by the kind or extent of liming, except for the evident repressions exerted by the heavy treatments of burnt lime and basic magnesium carbonate upon biological activities. The sulfate losses are about 75 pounds of SO_3. The calcium carbonate equivalences of the nitrate and sulfate leachings are approximately 135 pounds per acre, the remainder of the calcium and magnesium outgo being attributable to carbonate and bicarbonate combinations. Hence, two-thirds or more of the outgo of calcium + magnesium is due to bicarbonates.

In the parallel series in which the treated soils were underlain by one foot of red clay subsoil, the losses of both calcium and magnesium through leachings were diminished greatly because of the continued retention of these basic substances by the initially acidic clay subsoil. A detailed compilation has been made of the losses of the several nutrient elements from these variously limed soils during 25 years of exposure to rainwater leachings.

Conservation of Economic Additions of Liming Materials.—In this experiment the effects of 1-ton CaO-equivalent applications at 4-year intervals were compared with the effects of fractional annual applications of 4 types of liming materials—hydrated lime, limestone, dolomite, and calcium silicate—with variations as to depth of incorporation. The characteristics of the acidic Cumberland clay loam of this study are being compared with those of a coastal sandy soil used in an identical setup at the Virginia Experiment Station. The liming materials have not been applied since 1931, and the current results represent the residual effects of the various applications made at that time or prior thereto.

The original limestone applications made in 1924 and subsequently (series A, D, F, and G) now show a calcium + magnesium mean outgo of 30 pounds over that of the untreated soil. Differences due to division of treatment, nature of liming material, and zone of placement do not appear to be of sufficient magnitude to merit detailed discusssion. The additional applications made in 1928, and subsequently (series B, C, and E) show a mean increase of 72 pounds in outgo of calcium + magnesium over that of the control.

The group averages seem to show greater availability of the added bases at this stage as a result of the fractional application during the second 4-year period. It is also of interest to note that the calcium + magnesium losses from the untreated soils during the past year are offset by the increments derived from the rainwater.

LIME-POTASH STUDIES

The lysimeter phase of the experiment, in which the effect of the associated anion upon the absorption of potassium from 10 annual additions of its nitrate, chloride, and sulfate, was terminated. One phase of this study, namely the influence of limestone and of dolomite upon the recovery of the sulfate ion, is reported in a paper to appear in the January 1941 issue of *Soil Science*. The 10-year total of applied SO_3 was 1780 pounds for the ordinary treatments and 5689 pounds for the multiple treatments. The SO_3 increment from rainwaters was 1048 pounds for the 10-year period. The 10-year outgo of SO_3 from the untreated soils, Calhoun silt loam, Hartsells fine sandy loam, and Cumberland clay loam, was 995, 950, and 1108 pounds, respectively. The leachings from the untreated Calhoun soil contained 53 pounds less SO_3 than the rainwater for the year. Those from the Hartsells sandy loam contained 98 pounds less, whereas the SO_3 outgo from the Cumberland clay loam was 60 pounds more than the amount brought by rainfall. Using the total input of SO_3 as the basis of comparison, the leachings from the unlimed K_2SO_4-treated soils gave deficiencies of 156, 296, and 30 pounds of SO_3, respectively, for the three soils in the above-given order. By similar computations, the recoveries from the soils that received limestone applications with the K_2SO_4 treatments

were −95, −9, and + 168 pounds of SO_3. The corresponding recoveries in the rainwater leachates from the dolomite and K_2SO_4 treatment to the 3 soils were −10, +10, and +169 pounds of SO_3 in relation to the SO_3 input by treatment and by the rainwater increment. The well-buffered Cumberland silt loam, which has the highest proportion of colloids, exhibited no tendency to retain the SO_3 derived from the applied K_2SO_4 and rainwater during the 10-year period. The initially alkaline Calhoun silt loam showed only a slight tendency toward fixation of the applied sulfate ion. In general, the effect of liming was to accelerate outgo of sulfates during the first two years and thereafter to cause release of sulfates to the leachings.

The effect of a prolonged incidence of hydrated lime upon a build-up of potassium from previous annual K_2SO_4 additions in 5 soils has been investigated. The incorporations of hydrated lime were equivalent to a 32-ton treatment of CaO per acre. The early effect of the hydrated lime upon potassium outgo can be seen from table 26, showing results of leachings for the first annual period.

TABLE 26—*Effect of heavy incorporations of hydrated lime upon the leachability of previous additions of potassium.*

Soil	Amounts leached per 2,000,000 pounds soil			
	K_2O		Ca, terms of $CaCO_3$	
	Unlimed	Limed	Unlimed	Limed
	Pounds	Pounds	Pounds	Pounds
A. Jackson (naturally slightly alkaline)	116	203	220	5,072
B. Crossville	27	12	93	2,965
C. Sevierville	39	15	100	4,402
D. Chickamauga (naturally slightly alkaline)	45	52	815	5,117
E. Red subsoil	59	67	33	1,135

The larger fraction of the calcium outgo was in the form of $Ca(OH)_2$, as indicated by the abnormally high pH values (11 to 12) of the leachates, and determined by titration. The differences in the calcium outgo from the soils that received the heavy incorporations of caustic lime are due to difference in initial reaction values and unsaturation of Ca ions, and also to differences in absorption capacities. Soils A and D were well supplied with natural forms of calcium, and therefore showed the highest outgo of Ca during the first year after the $Ca(OH)_2$ treatment. The lesser leachings of calcium from the other soils may be attributed to absorption by the acidic colloids of those soils, the red clay subsoil apparently being the one of least degree of saturation.

The effect of the heavy lime treatment in soils B and C was to repress the outgo of potassium to the extent of some 15 to 25 pounds of K_2O. That treatment induced practically no change in the outgo of potassium from soils D and E, but it caused an increase of 77 pounds in the leaching of potassium oxide from soil A. The differential effects of the heavy hydrated lime treatment on the potash outgo from

the several soils point to the probability of inherent differences in the mineral colloids responsible for the differential absorptions of the prior additions of potassium sulfate in the several soils. The 4 soils that showed no appreciable increase in K_2O outgo after the heavy liming represent the widest contrasts as to total absorption capacity, as to degree of base saturation, and as to organic-matter content, and the results are probably indicative of the variable effect of such excessive treatment on the replaceable K in different soils.

Effect of Previous Liming on Potash Fixation.—In this experiment, the annual applications of 200 pounds of K_2O as K_2SO_4 to a Cumberland silt loam were begun 12 years after incorporation of various forms and amounts of calcic and magnesic materials and dolomite. In general, the leachate volumes of the past year were only about half of those of the previous year and the leachings of potassium, as well as calcium and magnesium, were much less. Slightly more than half of the 200 pounds of K_2O applied was held by the soil. The residues of the liming treatments incorporated in 1917 at the rates of 2000 and 3750 pounds of CaO per acre appear to be losing their repressive influence upon the outgo of potassium from the built-up supply of that element, but the 32-ton CaO treatment continues to exert a repressive effect upon potassium outgo.

LIME-PHOSPHATE STUDIES

The relationship of liming to the behavior of phosphatic fertilizers in soil is an important problem. The beneficial effect of superphosphates may be lost on sour, or lime-deficient, soils in which the water-soluble phosphates are converted to unavailable forms through fixation by iron and aluminum complexes. Conversely, injudicious liming may convert the soluble phosphates into forms less available and cause the formation of the very insoluble calcium fluorphosphate, the form that prevails in rock phosphate.

An experiment as to the effect of calcic and dolomitic limestones upon phosphate fixation has been conducted with a Cumberland clay loam, the "Ford" clay loam, and the "Jackson" silt loam, since 1930. The soils have been built up with annual applications of 96 pounds of P_2O_5 in the form of monocalcium phosphate. The phosphate outgo in lysimeter leachings from the Cumberland loam and the Ford clay loam has been in the low range of 0 to .10 pound of phosphorus per acre, and no definite effects of the supplemental liming treatments have been shown by the leachings. The cumulative phosphate outgo from any of the phosphatic treatments accorded these two soils for the 10-year period has not exceeded several tenths of a pound of phosphate from a total addition of 960 pounds of P_2O_5. The phosphate-outgo is much greater, however, from the Jackson silt loam, of comparatively low iron and aluminum content. The 10-year outgo

of phosphorus from the untreated slightly alkaline soil is 2.1 pounds; that from the unsupplemented phosphate treatment is 30 pounds; and that from the phosphated and limed group is 10 to 16 pounds. The outgo from dolomitic limestone is about 2 pounds greater than from the high-calcic limestone treatment. The incorporations of monocalcium phosphate with the soils limed previously with either calcic or dolomitic limestone gave phosphorus leachings 2.5 to 4.0 pounds greater than the outgo from phosphate incorporations that had been reverted to basic forms before incorporation. Although these findings as to phosphate outgo in the rainwater leachings cannot be translated directly into terms of phosphate availability to plants, they can be taken as manifestations of certain tendencies. Further tests of phosphate availability will be afforded when the soils that contain the accumulated additions become available for laboratory study and pot-culture experiments.

Recent laboratory and culture studies have shown that fluorine is a dominant factor in the reversion of calcium phosphate to a form of minimal solubility. It has been postulated that small amounts of fluorides likewise may induce phosphate unavailability in limed soils. A lysimeter study of fluoride outgo was begun in 1936 to investigate this possibility. Various phosphates were applied to a Clarksville silt loam at the rate of 1280 pounds of P_2O_5 per acre. Some of the phosphates were supplemented initially with 160 pounds of fluorine in the form of calcium fluoride. The initial incorporations of phosphate with limestone and with dolomite were not repeated, but the fluoride additions were repeated at the rate of 320 pounds per annum. Hence, there has been a total addition of 1120 pounds of fluorine, 800 pounds of which had been in the soil prior to the acquisition of the present results. The annual outgo of fluorine from the untreated soils was in the range of 0.1 to 0.3 pound, and that from the fluoride-treated soils was in the range of 1.5 to 3.0 pounds. Neither total nor differential outgo is yet of sufficient magnitude to warrant conclusions as to the effect of either the phosphate or the liming treatments upon the activities of fluoride additions.

The increasing usage of ammoniated superphosphate and the introduction of new types of phosphates and partially defluorinated fused rock phosphate bring up the question of the differential soil-behavior of phosphates of acidic and basic characteristics. A limited number of lysimeters therefore were allocated to an exploratory study in 1938. A Hartsells sandy loam of distinctly acidic character was used to test the properties of the basic phosphates, and a Dewey silt loam, well supplied with calcium and magnesium, was used to test the potential acidity of the ammonium phosphates. The acidic soil received monocalcium, dicalcium, tricalcium, and fused-rock phosphates. The neutral soil received monoammonium and diammonium phosphates, orthophosphoric acid, and also ammonium sulfate, to differentiate between the acidic activities of the NH_4 ion in its association with the

SO_4 and PO_4 radicals. The initial treatments have been repeated annually at the rate of 320 pounds of P_2O_5 per acre.

The current results register the compositions of the leachings after the second annual treatment. The nitrogen outgo registers 90 percent nitrification for the monoammonium phosphate and for the ammonium sulfate, and 66 percent for the diammonium phosphate. The calcium and magnesium removals from the soil closely parallel the degree of nitrification of these materials, whereas the ammonium sulfate treatment caused a removal of calcium and magnesium to combine with the full amount of the sulfate addition.

The acidic soil showed a decisive drop in calcium outgo below that of previous year. The outgo of 69 pounds of calcium is less than the rainwater increment, against a slight increase in the outgo of magnesium and a large increase in outgo of potassium as a result of an unbalanced acid-base relationship. The additions of calcium phosphates of variant degree of basicity resulted in a uniform increase in outgo of calcium, an approximate equivalence of 180 pounds of calcium carbonate. Increase in rate of either nitrification or sulfofication was not decisive. The increase in calcium outgo may be attributed, therefore, to the effect of the basic phosphates in the neutralization of the biologically produced acids. From this year's results, it appears that the strongly acidic soil is able to draw upon the calcium of the monocalcium phosphate as well as from that of the dicalcium and tricalcium forms. No such increase in calcium outgo from the calcium phosphate additions to the acidic soil was observed in the results of the first annual period.

SULFATE RECOVERY STUDIES

The role of sulfur as a nutrient has received particular attention since the introduction of more concentrated forms of phosphatic fertilizers. These concentrates contain only small quantities of calcium sulfate, in contrast with the substantial quantities that characterize ordinary superphosphate. A lysimeter experiment was inaugurated to throw light upon the question as to how long added sulfates are retained by the soil. The several sulfates of calcium, magnesium, and potassium have been applied annually to a Cumberland loam, with and without initial supplements of limestone and dolomite. Complete recovery of all the magnesium sulfate additions was obtained during the past season, against a deficiency of about 100 pounds in the recoveries from the 400-pound incorporations of calcium sulfate. A similar deficiency in recovery was obtained from the additions of potassium sulfate at both 400-pound and 800-pound rates, irrespective of any other treatments. It has been noted, however, that the leachings of the past year were below normal because of the heavier summer precipitation, and it is probable that some of this retained sulfate will be recovered during the succeeding year.

NITROGEN AVAILABILITY STUDIES

The recovery of nitrogen from several nitrogenous materials has been determined in a 10-year agronomy-chemistry lysimeter study. A Cumberland loam and a Jackson silt loam were used. Six materials—sodium nitrate, ammonium sulfate, urea, "ammophos", cottonseed meal, and cyanamid—and the untreated soil constitute a series. Two series were run unlimed in comparison with two corresponding series limed with one initial limestone treatment at the rate of 2 tons per acre. The present results are those of the second year after the manner of treatment was modified so that the several materials were incorporated in the surface 3 inches of soil during the summer months. Better correlation was obtained than when the materials were applied on the surface during the winter season. The limed Cumberland loam yielded from 90 to 100 percent of the nitrogen added as sodium nitrate, ammonium sulfate, urea, and ammophos, and about 2/3 recovery of that added as cottonseed meal and as cyanamid. The nitrogen recoveries from the 4 first-mentioned materials were somewhat lower on the unlimed soil, whereas recoveries from the cottonseed meal and cyanamid were comparable for limed and unlimed soil. A similar relationship was shown by the Jackson silt loam as to the effect of liming upon nitrogen recovery. The depletion of calcium+ magnesium from the unlimed soils amounted to 175 to 185 pounds per acre above the rainwater increment of those elements during the past year.

The influence of acid-radical combinations upon nitrogen recoveries from ammoniacal fertilizer salts has been under study since 1932. Annual applications of 33 pounds of nitrogen as monoammonium phosphate, diammonium phosphate, ammonium sulfate, ammonium chloride, ammonium nitrate, and ammonium hydroxide were made on the Jackson silt loam, Cumberland clay loam, and Crossville sandy loam. The latest treatment was made in June 1939, and the preceding treatment was made in March 1938, and the effect of the 1938 treatment was divided between the composited leachings of 1938 and 1939. A considerable part of the ammonium radical was nitrified and leached as nitrates during the spring of 1938, and this transition was reflected by the low base content of composites of the 1939 leachings. The nitrogen outgo from the Jackson silt loam showed 15 to 35 percent recoveries of the latest applications. The mean recovery from the Crossville soil was 30 percent; that from the Cumberland clay loam was 68 percent. The highest recovery for this year was from the addition of monoammonium phosphate. The cumulative acidic condition of these soils is probably responsible for their present low nitrifying efficiencies and the low nitrate content of the leachings.

The effect of a 5-foot depth of clay subsoil upon the recoveries of nitrogen from the chloride, sulfate, and phosphate of ammonia has been studied since 1934. This project is one correlated with a pre-

vious 10-year study of the outgo of the same single heavy rate of nitrogen incorporation through the nitrates of sodium, calcium, and magnesium. The present results are those of the fifth year after the single 989-pound application of nitrogen. No substantial effect of the single treatment can be seen from the analyses of the leachates for current content of nitrogen, sulfates, calcium, magnesium, and potassium. About 80 percent of the heavy addition of nitrogen has been recovered during the past 4 years. The chlorides were leached almost completely during the first and second years, but outgo of sulfates and also phosphates has been practically nil. The aggregate outgo of calcium, magnesium, and potassium has kept pace with the sum of the acidic radicals other than CO_3 in the leachates.

DETERMINATION OF EXCHANGEABLE BASES

The quantity and nature of the exchangeable base content exert a marked influence upon the characteristics of a soil. A joint consideration of exchangeable base content and exchange capacity affords an accurate estimation of the lime requirement of a soil. The procedures for the determination of exchangeable bases call for the leaching of the soil with a neutral salt, usually either ammonium acetate or ammonium chloride, and the analysis of the leachates for incidence of calcium, magnesium, and potassium. The amount of the ammonium radical retained by the soil is equivalent to the sum of the bases removed, plus the major part of the exchangeable hydrogen. The determination of the ammonia retained by the soil is a measure of the total exchange-capacity of the soil.

Because of the nature of some of the lysimeter experiments with liming materials, it was deemed necessary to investigate the exchange properties of the soils that are still characteristized by substantial proportions of calcic and magnesic carbonates. Such investigations have afforded information that suggested improvements in analytical methods. For a soil containing only one carbonate, either calcic or magnesic, it was found most expeditious to determine the bases extracted by a boiling digestion with ammonium chloride and then correct for the separately determined soil content of carbonates. The exact determination of exchangeable magnesium can not be made by any of the present procedures, when the soil contains undecomposed dolomite.

Studies as to the solubility of limestone and of dolomite in neutral ammonium acetate solution has led to development of an analytical innovation. It was demonstrated that the addition of a small quantity of $CaCO_3$ admits of the extraction and determination of all the exchangeable calcium and magnesium without interference from the magnesium component of any dolomitic limestone present in the sample. The data were presented before the Association of Official Agricultural Chemists at its 1940 session, and will be published in its journal.

The exchangeable hydrogen content of soils of a humid region is the most important determinable value. This value is estimated now from determined pH values and is computed as the difference between total exchange capacity and exchangeable-base content of the soil. Although such an estimation is easy, it connotes the degree of acidity and does not give a quantitative expression of the lime requirement of a soil, whereas the above-mentioned chemical technic is not feasible as a routine procedure. Hence, a laboratory study was undertaken to evolve a simple direct determination of exchangeable hydrogen content of a soil, which would serve to establish a soil's "lime requirement." Work is now in progress as to the several factors that affect the quantitative determination of the replaceable hydrogen. Among these are the effects of salt concentration, equilibrium pH values, cation of the replacement solution, ratio of liquid to solid, effect of temperature, and duration of contact.

NEW FERTILIZERS AND BY-PRODUCTS

In the development of new fertilizers, small quantities are made in the laboratory and then in semi-works operations. The characteristics of the experimental materials are determined by exploratory chemical studies that require either the adaptation of analytical procedures or the evolution of new analytical technics. Such studies have been conducted upon the products and by-products and upon their chemical behavior outside and in the soil after they are subjected to corrective, eliminative, and alternative treatments in the laboratory.

An analytical technic was evolved for the accurate determination of the fluorine content of the ash of plants grown in association with solvated silica and phosphates supplied by additions of calcium silicate slag.

The chemical characteristics and liming value of calcium silicate slag were studied. The possibility of an immediate toxicity from heavy additions and an ultimate effect from repetitions of moderate treatments have been studied and a progress report has been made.

Superphosphates have been made through the hydrolysis of calcium metaphosphate under autoclave treatment, and corresponding dibasic phosphates have been made through the hydrolysis of calcium metaphosphate by similar treatment of metaphosphate with additive calcic, magnesic, and dolomitic materials.

A method of low-heat treatment of green superphosphates has been found to induce (a) immediate stability and absence of free acid, without appreciable loss of P_2O_5 availability, (b) concentration of about 15 percent, and (c) removal of 60 percent of the fluoride content in forms easily conserved for usage as insecticides.

Laboratory and pot-culture studies have been conducted to establish the relation of degree of defluorination of rock phosphate in

fused rock phosphate, characterized by content of synthetic hedenbergite, to P_2O_5 availability evaluations by several chemical procedures. In comparisons of the solubility coefficients of the respective separates of recalcitrant fused experimental phosphates, it was found necessary to bring all analytical charges to 325-mesh to assure reproducibility of analytical results. It has been found that substantial degree of defluorination and fineness of at least 80-mesh are essential to satisfactory response in pot cultures.

Correlation has been given the cumulative findings as to the role of component fluorides of superphosphates in their mixtures with basic phosphates and with various liming materials before and after incorporation with soils. It had been demonstrated that fluoride-free superphosphates can be mixed with rational proportions of different liming materials without causing retrogradation. Such phosphates had been ammoniated fully without development of the citrate-insolubility that is encountered in the partial ammoniation of commercial superphosphates. It had been found that the fluoride content of superphosphates also causes serious P_2O_5 reversion in their mixtures with defluorinated powdery rock phosphate. In contrast, it was found that the glassy fused rock phosphate is compatible with superphosphates. Interpretation of the findings prompted a new concept as to the ultimate phosphate formed from incorporations of superphosphate in limed soils. Apparently the water-soluble phosphates pass through successive calcic combinations to the final insoluble fluorphosphate combination, analogous to the apatite of rock phosphate. The practical interpretation of some 14 years experimentation with mixtures of phosphates and liming materials is being prepared for presentation in bulletin form, and the concept will be dealt with in a technical paper.

W. M. Shaw has served the A. O. A. C. as Associate Referee for Liming Materials. W. H. MacIntire has served that Association as General Referee for Soils and Liming Materials, as its designate on the board of Governors of the Crop Protection Institute, and also as Chairman of the committee responsible for the Wiley Memorial Awards.

ECONOMICS AND SOCIOLOGY

C. E. Allred

Activities of this Department during the year have been directed toward studies of some of the more important economic and social problems in Tennessee, the solution of which will aid in the agricultural progress and general development of the State.

Results of research studies were published in 22 monographs, totaling 843 pages, and 5 typewritten manuscripts of 994 pages. A total of 858 copies of monographs were sent to 39 agencies on the

regular mailing list, and 4114 were sent to 34 libraries in Tennessee and other states. In addition, 315 written requests for monographs were received from various agencies and 558 copies were mailed. Since the Department was organized it has published or typed 21,557 pages of research results, of which 1837 were completed in 1940.

The Department has received and answered a large number of inquiries for information on rural economic and social problems of Tennessee, and members of the staff have attended several conferences both within and outside the State. Many meetings were held with officials of the U. S. Bureau of Agricultural Economics on program and land-use planning studies now in progress in Tennessee. Thirty-one meetings of the Land Grant College-BAE Committee were attended by the Agricultural Economist.

Work on projects is summarized as follows:

FARM TAXATION

Research on farm taxation was continued. In cooperation with the WPA Division of Social Research and the Federal Bureau of Agricultural Economics, data were secured in two counties on several aspects of land-use planning. A study was made of the relation of tax assessments and tax delinquencies to soil class, and a publication was issued embracing the work in one county: "Some Economic Factors Associated With Land Class in Overton County, Tennessee." Monograph 100, 57 pages.

In that area tax assessments were about 60 percent of sale price, the ratio of assessment to selling price varying more widely between civil districts than between land classes. A close relationship exists between land class and overdue taxes. Another finding of importance is that in that area there is no concentration of mortgage indebtedness on a particular land class.

TABLE 27—*Selling price, assessed valuation, and ratio of assessment to selling price, 1616 voluntary sales of farm real estate, Overton County, Tennessee,* 1920-1934.

Civil district	Acres sold	Selling price per acre	Assessed value per acre	Percent that assessment is of sales prices
1	6842	$24.54	$11.54	47.0
2	5750	11.76	7.75	65.9
3	9254	14.69	9.40	64.0
4	2384	12.19	5.22	42.9
5	9146	15.27	8.94	58.5
6	11222	20.28	12.59	62.1
7	7628	15.15	8.25	54.5
8	6238	10.90	7.19	66.0
9	8943	8.59	4.79	55.8
10	4284	9.36	6.42	68.6
11	10672	17.73	11.70	66.0
12	6006	8.94	5.24	58.6
County	88369	14.82	8.87	59.9

TYPES OF FARMING

Data were secured on crop rotations used in type-of-farming areas 3, 11, and 14, and the following reports prepared: "Cropping Systems in Tennessee," typewritten manuscript, 174 pages; and "Crop Rotations Practiced in Tennessee Type-of-Farming Areas 3, 11, and 14," Monograph 116, 27 pages. These studies show the way farms in those areas are actually cropped, the major crop rotations followed in each type-of-farming area, the chief crops and crop combinations being used in those areas, and the characteristics of specific fields in relation to the rotations now being practiced.

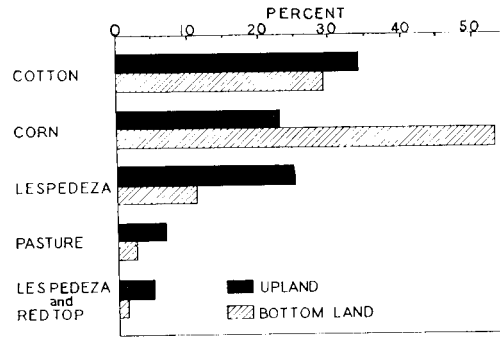

Fig. 23—Percentage of fields planted to important crops: 45 farms, Crockett County, Tennessee, 1932-1936.

Analysis was made of profitable farm combinations and practices in area 3, West Tennessee, and the following report issued: "Factors Affecting Farm Profits in Area 3, West Tennessee," Monograph 107, 37 pages. Some significant findings of this study are: (1) Some farmers increase their labor incomes by improving the quality of the product grown, and others by expanding the size of their enterprise; (2) one of the most important factors influencing farm income is changes in crop yields; (3) on farms with highest labor incomes, from 30 to 60 percent of receipts usually come from cotton, but each of the better-income farms has 6 or more sources of income amounting to more than the amount of farm taxes; (4) farms having the highest labor incomes average 250 days of man labor for the farm operator, with a total of 523 days of productive work.

In cooperation with the Division of Farm Management and Costs of the Bureau of Agricultural Economics, a study was made, at the request of the county land-use planning committee, to determine the effects of certain adjustments in farm organization on the incomes of different types and sizes of farms. The adjustments considered were those recommended by the county committee and certain practices recommended for individual farms by specialists of the College of

Agriculture. A report was prepared showing farm organization at present and that suggested for each of 12 sample farms. Summaries were included of major problems and suggested adjustments for each size group. This report, entitled "Adjustments on Selected Farms in Roane County," 140 typewritten pages, will be processed by the Bureau of Agricultural Economics. It is expected that a more popular type of bulletin based on this study will be published by the Experiment Station at a later date.

A farm-management and land-use planning study was begun in District 4 in Roane County to determine the relation of soils to crop yields, the relation of various factors to farm earnings, and other aspects.

A study was begun in Roane County to determine the possibilities of readjusting the farm families to be displaced by the Watts Bar

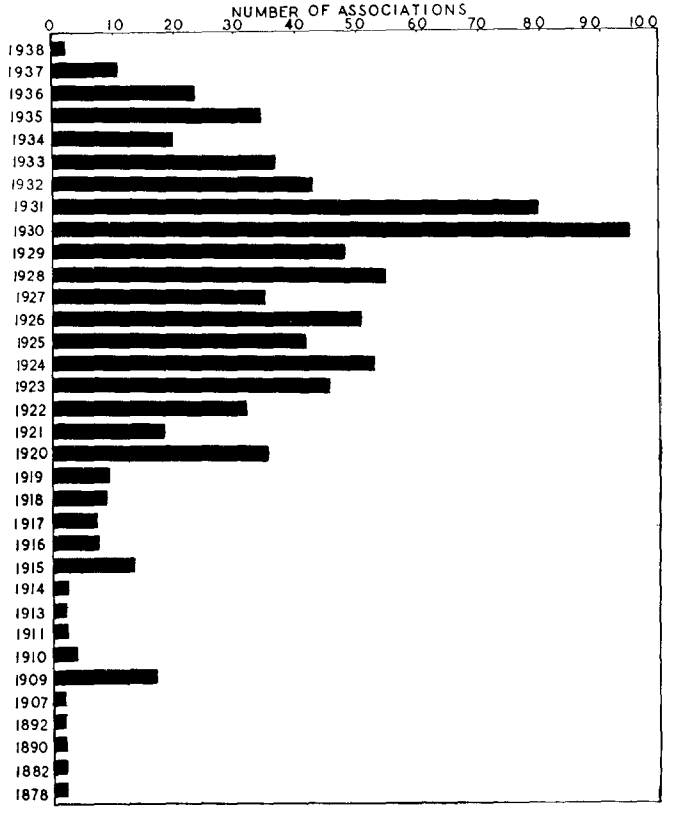

Fig. 24—Associations failing or becoming inactive, by years: 820 farmers' cooperative selling and purchasing associations, Tennessee, 1878-1938.

reservoir. These families are of two types: (1) those whose farms will all be purchased and who must move, and (2) those who may retain part of their land and who can remain at their present locations if plans are worked out whereby they can prosper there.

COOPERATIVE MARKETING

The study of cooperative marketing organizations was continued, and data on the status and development of cooperative business organizations in an East Tennessee county were obtained. The cooperative experience of rural communities in that county should be of considerable value to farmers in other areas of the State who are interested in solving their problems through joint effort. Attention is being given to a successful mutual fire insurance company operating in the county, as an example of the way such organizations might be made to function in other counties.

In cooperation with the Tennessee Valley Authority, Division of Cooperative Research, a survey was made in 1939 of active farmers' cooperatives in Tennessee. A second preliminary report on the results of the study was typewritten this year: "Survey of Farmers' Selling and Purchasing Cooperatives in Tennessee," 28 pages. This report is of special value to organizers of cooperatives; it shows the causes and agencies instrumental in cooperative development, why cooperatives were organized, and why some have gone out of business.

COTTON MARKETING

In cooperation with the Cotton Marketing Division, U. S. Department of Agriculture, the work of securing data on cotton quality and related cotton-marketing studies was continued. In 1940, samples were secured from 29 ginners representative of the cotton counties of

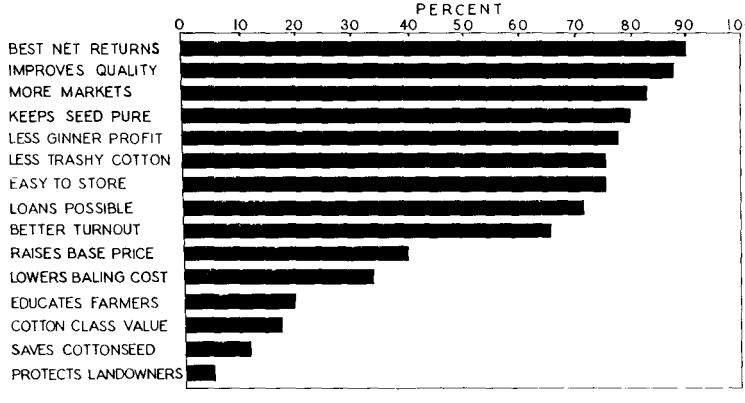

Fig. 25—Percentage of farmers giving specified reasons for selling in the lint: 500 farmers, Tennessee, 1937-1939.

the State. On the basis of samples received from these gins, the Federal Division, in cooperation with the Station, continued publishing semi-monthly cotton grade and staple reports.

For this season, in Tennessee reports show improvement in cotton staple over any previous season since the project was initiated.

A field study of ginning machinery and practices was made and the results were published in "Cotton Ginning Equipment and Practices in Tennessee," Monograph 101, 34 pages. This study has been of value to the cotton farmers and ginners of the State in showing the status of ginning equipment and in suggesting methods of improving ginning practices and conditions.

A study of selling cotton in the seed was completed and the results published in "Selling Cotton in the Seed in Tennessee," Monograph 106, 46 pages. This report already has proved of value to cotton farmers, pointing out many causes and effects of this method of selling cotton, the volume and distribution of the practice, and reasons for and against the method as revealed by a survey of farmers, ginners, cotton merchants, and spinners.

The number of one-variety cotton-improvement associations organized to qualify for cotton-classing and market-news services, under the Smith-Doxey Act, increased from 8 in 1938 to 12 in 1940. A study was made to determine the benefits derived by growers from Smith-Doxey services, and to show some of the more important economic aspects of marketing as found in one-variety cotton communities. A preliminary report was issued: "Economic Aspects of One-Variety Cotton Communities in Tennessee," Monograph 111, 37 pages. This study has proved of value to cotton farmers and agricultural workers in indicating the superior quality of cotton produced by members of one-variety communities, showing the effects of seed source on staple length and lint percentage, discussing methods of selling, and suggesting ways of improving cotton-marketing conditions.

An economic analysis was begun this year of the methods of storing lint cotton in Tennessee. Field data were gathered from farmers, ginners, and warehousemen, the results of which will be prepared for publication.

SOUTHERN APPALACHIAN STUDY

Work on the Southern Appalachian project was continued, progress reports on several aspects of the work being published. The survey of wholesale fruit and vegetable marketing in Knoxville and its trade area, begun in 1939, in cooperation with the Knoxville Chamber of Commerce, was completed and the following reports were issued:

"Knoxville Wholesale Fruit and Vegetable Market," typewritten report, 213 pages.

"Knoxville Wholesale Fruit and Vegetable Market: Part I, Buyers

and Buying Problems," Monograph 115, 34 pages; "Part II, Taxes and Regulations," Monograph 118, 22 pages; "Part III, Supply," Monograph 119, 38 pages; "Part IV, Facilities," Monograph 120, 30 pages. These studies, undertaken to obtain basic data helpful in planning an efficient and adequate wholesale market for Knoxville, should prove useful to persons interested in solving the problems of similar markets in other cities of the State.

A survey of the wholesale seed trade of Knoxville and its trade territory was begun to determine more accurately the extent and origin of the imports in relation to what local farmers might produce.

A study of livestock marketing in East Tennessee has been initiated and cooperation of livestock marketing agencies obtained in furnishing marketing information.

Work was continued in cooperation with the Bureau of Agricultural Economics, United States Department of Agriculture, on the relations of land quality to certain economic factors. A study of the use to which land is put in farms differing in size and soil quality was completed and the findings published: "Relation of Land Use to Land Class, Jefferson County, Tennessee, 1938," Monograph 104, 59 pages. This study shows the variations in the use of land on farms with soils of differing productiveness, and the soil-building practices followed by farmers in the county. These data will enable the county land-use planning committee to adapt its recommendations more specifically to farms of different sizes and soil qualities.

A study was made of factors involved in the readjustment of families that had to move to new homes because of land acquisition in the Norris Reservoir area. A typewritten report of 190 pages on the study was prepared for use by the TVA and the Relocation Division of the Agricultural Extension Service. It is entitled, "Readjustment of Families Displaced by Norris Reservoir." The report shows the progress made by families moved out of the reservoir area, and the social and economic conditions of the families before and after relocation.

At the request of local and county land-use planning committees, this Department, in cooperation with the Bureau of Agricultural Economics, made a compilation of available research data and published the results in "Basic Maps and Materials Available for Land Use Planning in Tennessee," Monograph 109, 45 pages. For 9 counties, designated as either "unified" or "intensive" counties in land-use planning work, special reports of information available were prepared, under the general title, "Basic Data on Tennessee Counties." These reports covered the following counties: Roane, Jefferson, Claiborne, Coffee, Giles, Bledsoe, Henry, Hardin, and Humphreys. Monographs 102-A to 102-I, 70 pages.

At the request of the Roane County land-use planning committee, in cooperation with the Bureau of Agricultural Economics, an eco-

nomic and social analysis was made of an area which was tentatively designated by the county committee as unsuited for farming. A report was published of this study, entitled, "Farming Possibilities in a Problem Area of the East Tennessee Valley," Monograph 114, 53 pages. This report analyzes the population, home factors, and resources of the area, discusses agricultural characteristics and conditions, and shows the family incomes, expenses, and social contributions. In addition, the report sets forth the possibilities of the area, including possible systems of profitable farming for farms of different types.

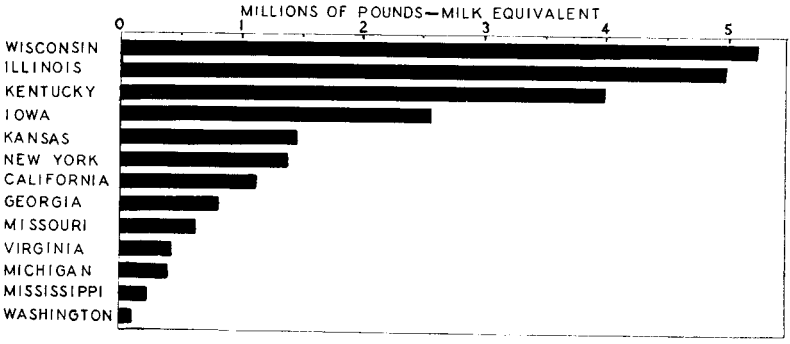

Fig 26—Out-of-state origins of dairy products shipped to Knoxville, 1938.

The study of imports of dairy products into the Knoxville trade area, begun in 1939, was completed and a report issued entitled, "Shipments of Dairy Products into Knoxville, Tennessee," Monograph 103, 24 pages. This report shows the extent of dairy imports and the origin of shipments by states and by distributors, and identifies the trade territories of Knoxville wholesale distributors.

OTHER RESEARCH

Prices of Farm Products.—In cooperation with the Tennessee Division of Crop and Livestock Estimates, U. S. Agricultural Marketing Service, the Department continued publishing monthly index numbers of prices received by Tennessee farmers.

Two studies were completed on prices paid by farmers for various commodities, by areas, in Tennessee. The results of these studies were published as follows: "Regional Prices Paid by Tennessee Farmers for Food," Monograph 108, 24 pages; and "Regional Prices Paid by Farmers for Farm Supplies," Monograph 121, 30 pages. These reports indicate important factors which cause regional variations in prices and the extent of these variations.

Data were tabulated and analyzed during the year on prices farmers received in various regions of the State, and the following publi-

cation issued: "Regional Prices Received for Farm Products in Tennessee and United States," Monograph 110, 48 pages. Knowledge of regional price variations gives Tennessee farmers information on which they may base future plans and decisions. A significant feature of this report is its summary showing the percent that regional prices within Tennessee are of the State price for regions of highest and lowest prices, and the percent that the Tennessee price for each commodity is of the United States average.

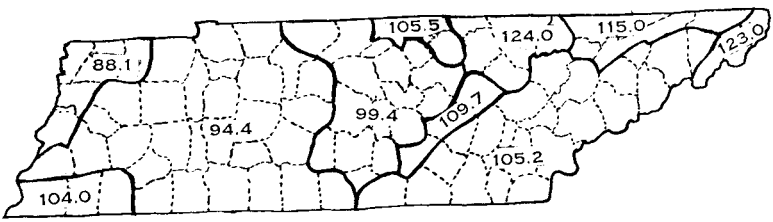

Fig. 27—Corn: Regional price differences, shown as percentages of the state prices, 1929-1935.

Average state price: 67.8 cents per bushel.

Rural Social Studies.—Work was continued on the relation of land quality to certain social factors, such as mobility, relief, and the educational attainment of public school children, a report being issued for one county: "Social Factors Associated With Land Class in Overton County, Tennessee," Monograph 105, 36 pages. This study shows that families on poor lands moved more often than those on good lands, but shorter distances, while families on good lands tend more often to move out of the county. Public relief is 5 times as great on the poorest land as on the best land. Croppers and farm laborer families make up a large percentage of the relief load on all land classes. Farm children from the better lands are absent from school 8 days less than those from poor lands and are one-half year more advanced in grade.

Farm Tenancy.—Work begun in 1939 designed to evaluate some State and Federal proposals related to farm tenure was continued and the results were summarized: "Pros and Cons of Tenancy Suggestions," typewritten manuscript, 277 pages; and "Landlord-Tenant Relations in Roane County, Tennessee," Monograph 117, 32 pages. The latter gives a picture of agricultural leasing arrangements in Roane County, including length, renewal, and termination of leases; rental compensation; methods of paying rent; methods of settling disputes; and limitation of liens.

ENTOMOLOGY

S. Marcovitch

PLUM CURCULIO

Two sprays of cryolite, at the rate of 2 pounds to 50 gallons of spray material, do not injure foliage, but will cause tip-end injury

on peaches. From test at the Experiment Station and in the Wallace orchard, near Knoxville, the 10-day spray was determined to be the cause of the injury. Since the shuck-fall spray seems to be safe, it appears that a "split" spray schedule, using cryolite in the shuck-spray and lead arsenate in the 10-day spray, will result in the smallest amount of injury to fruit and foliage.

A proprietary material known as "Silex" was tried. This consists of dicalcium phosphate and about 10 percent fluorine. It was believed that the presence of the dicalcium phosphate might act as a corrective against fluorine injury. Tests of Silex alone and with cryolite were carried out. Injury to the fruit was produced in both tests.

FACTORS INFLUENCING THE M. L. D. OF INSECTICIDES FOR THE TOBACCO HORNWORM

Until recently the insecticidal value of stomach poisons was determined principally by the cage method. Since the advent of the newer insecticides, such as rotenone and fluorine compounds, Campbell and others have devised accurate quantitative methods for the expression of the relative toxicity of these insecticides; that is, the median lethal dose (M. L. D.) per unit of weight.

Under the complex conditions in the field or orchard, one cannot get an accurate comparison of two materials. Conditions can be better controlled in the laboratory for the study of the toxicology. Ordinarily, the dose, time to kill, and weight of the insect are considered in determining an M. L. D. Seemingly insignificant differences in method may alter the figures to a marked degree. The following variables, or factors, have been found to be of importance: (1) Deposit of insecticide per unit of area, (2) quantity of foliage consumed, (3) time required for feeding, (4) weight of insect, (5) specificity, (6) temperature, and (7) solubility.

With a deposit of .21 mg. per sq. cm. we obtained an M. L. D. for cryolite of .21 mg. per gram body weight. Only ½ to 1 sq. cm. of foliage was consumed.

A deposit of .01 mg. per sq. cm. was non-toxic. The larvae ate 23 sq. cm. of food and consumed a dose of .37 mg. of cryolite. This same amount of poison consumed on ½ sq. cm. of food would prove lethal in less than 24 hours. The extremely large amount of food in comparison to the amount of poison seems to act as an antidote.

Time elapsed in feeding also is important. A deposit of .02 mg. of cryolite failed to kill overnight, but showed a lethal effect when the larvae were allowed to feed several days.

Another important factor is the weight of the worms. Small worms are more readily killed than larger worms, since they eat more in proportion to their weight.

In comparing two materials, other factors that must be kept in mind are particle size, solubility, and repellence.

Lastly, the question of specificity should not be lost sight of. Campbell found that to the silkworm sodium fluosilicate and lead arsenate are equally toxic; yet Richardson found that to grasshoppers the fluosilicate is 19 times more toxic than lead arsenate.

In our tests on lima beans, we found magnesium arsenate ineffective against the corn ear worm, whereas cryolite gave good control.

Paris green, with an M. L. D. of .015, is nearly 6 times as toxic in the laboratory as lead arsenate, with an M. L. D. of .085; yet lead arsenate will give better control of the hornworm in the field because of its superior physical properties and adhesiveness.

These illustrations show the many variables one meets in evaluating the effectiveness of two materials, both in the laboratory and in the field.

ROSY APPLE APHIS

The rosy apple aphis and its work are well known to fruit growers. Since the aphis causes severe curling of leaves, it is difficult to reach with a spray. The eggs, however, are exposed during the winter season. Dormant sprays were tried out consisting of "DN" powder, coal-tar acid, Elgetol, and crude naphthalene. The "DN" powder is dissolved in oil when ready for use. The Elgetol is a dinitro insecticide in water-soluble form.

Good control was obtained against the rosy apple aphis with the "DN" powder and 2½-percent tar oil. The 1-percent Elgetol seemed less effective, while 10-percent naphthalene with 3-percent oil emulsion produced no effect.

Counts made on the San Jose scale indicated that the crude naphthalene increased the control and effectiveness of the oil emulsion.

TOMATO FRUIT WORM

The tomato fruit worm is rather difficult to control with ordinary sprays. Tests with various baits indicate that good control can be obtained with a bait composed of corn meal or cottonseed meal and 10-percent cryolite. This method is very simple and inexpensive and requires no machinery. A pinch or two is applied to the developing clusters of tomatoes. The worms are fond of this bait. They eat it and do not enter the tomato.

In 1940, baits reduced the infestation to 9 percent, while the check plots with no treatments showed 47 percent injured fruit. The baits have the additional advantage of being non-poisonous.

Tests with corn as a trap crop showed it to be of no value. Light traps also were of no value.

THE MORE IMPORTANT INSECTS OF 1940

The cotton louse, *Aphis gossypii*, was abundant on small cotton in June in various parts of the State. It might have caused much damage but for the ladybird beetles and other natural enemies, which kept them in check.

In Middle Tennessee, the elm leaf beetle (*Galerucella xanthomelaena*) appeared in destructive numbers.

The tobacco hornworm (*Phlegethontius sexta*) was very scarce. It did not appear until late in the season, after the tobacco was grown. Why the infestation was below normal is difficult to explain.

HOME ECONOMICS

Florence L. MacLeod

During 1940 the study of the ascorbic acid (vitamin C) metabolism of college students was started. The blood plasma ascorbic acid for 18 freshmen students was determined at different times, by the Farmer and Abt Micro method. In two cases, excretion tests on 24-hour samples of urine before and after taking 300 mg. of ascorbic acid were made to find the effect of the large intake on the excretion level. Determinations of the basal metabolic rates of some of the students were also made. Too few results have been obtained to warrant the publication of figures at the present time. In line with the findings of other workers, only blood ascorbic acid determinations will be made in the future, and for all work the Evelyn photoelectric colorimeter will be used.

Some intensive investigations were made, with two graduate students as subjects, to find the level of ascorbic acid intake which would keep the blood-plasma ascorbic acid at the saturation level. The students were first given their usual diet plus several oranges a day until the plasma ascorbic acid remained at a high level for three or four days. They were then placed on a weighed basal diet which was adequate in all respects with the exception of vitamin C, and in addition were given a known amount of pure ascorbic acid each day. Ascorbic acid determinations of blood plasma were made every day for several days. The subject was again saturated for a few days and another level of ascorbic acid was given in addition to the basal diet. With an intake as high as 200 mg. a day, it was found impossible to keep either subject at her saturation level.

Some determinations of the ascorbic-acid content of fresh and frozen strawberries and asparagus were made during the year.

HORTICULTURE

Brooks D. Drain, A. B. Strand, and D. M. Bailey

LEAF SPOT-RESISTANT TOMATOES

During the seasons of 1939 and 1940, 298 introductions of 5 tomato species were tested for leaf-defoliation resistance. Selections were

made for *Alternaria* resistance in *Lycopersicon hirsutum*. Selections for *Septoria* resistance could not be made during either season, because the disease failed to appear in the experimental plots.

The 4 most promising selections of *L. hirsutum* have been crossed with commercial varieties. Leaves of the F_1 hybrid shown in figure 28 appear to be resistant to defoliation caused by *Alternaria*. The inter-

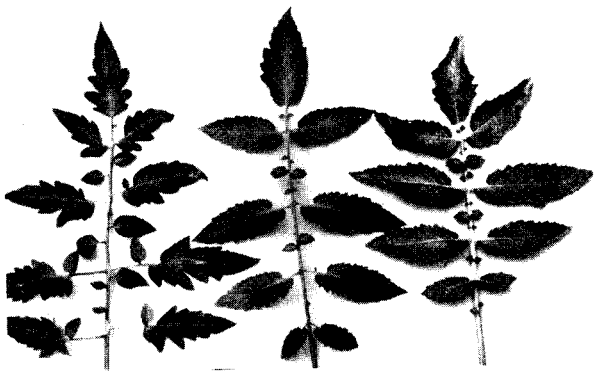

Fig. 28—Leaves of *Lycopersicon esculentum*, *L. hirsutum*, and the F_1 resulting from the cross of these two species.

Left, leaf of Indiana Baltimore, a commercial tomato variety usually attacked by defoliation diseases during the latter part of the growing season. Center, F_1 leaf of Indiana Baltimore x *L. hirsutum*. Right, leaf of *L. hirsutum*. This species is not attacked by defoliation diseases to as great an extent as the common varieties.

specific hybrids were backcrossed to commercial varieties and the progeny field tested. Since many inherited characteristics of the wild parent are considered undesirable, it will require several years' work to obtain commercial quality and disease resistance.

Because of the severity of nematode in certain areas of the State, the breeding of tomato varieties for tolerance to *Heterodera marioni* was started. An inexpensive method of testing for tolerance resulted from the inoculation of tomatoes with root-knot tissue at the time of seeding. Less than 3 weeks is required, under optimum conditions, to produce the severe infestation symptoms in seedling roots shown in figure 29. Over 100 commercial varieties have been tested, all of which were found susceptible. Seed lots from the U. S. Department of Agriculture, Bureau of Plant Industry, Division of Plant Introduction and Exploration, are being tested. In tests made on 475 of these introductions, one species, *L. peruvianum*, offers considerable promise as a source of resistant parental selections.

RED RASPBERRY IMPROVEMENT

A fall-bearing seedling from the red raspberry-improvement

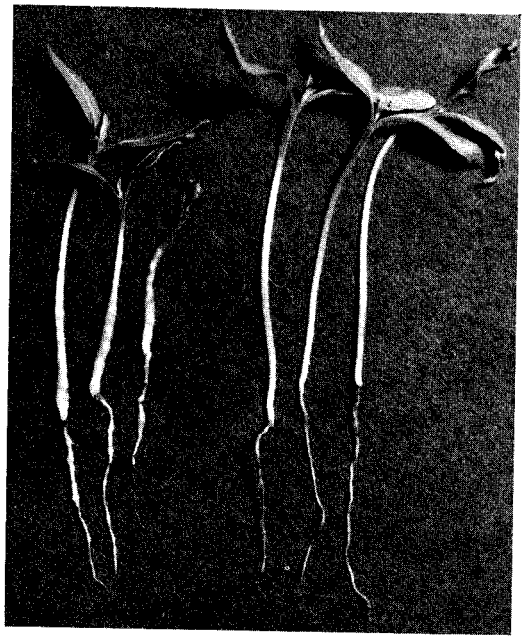

Fig. 29—Seedling tomato plants infested with root-knot nematode.

The three plants on the left were inoculated with nematode, at the time of seeding, by means of chopped root knots placed in the soil. The three plants on the right were grown in soil free of nemas. Note the uniformity of these check plants in comparison with the severly injured ones.

project was named "Tennessee Autumn," Plant Patent Serial No. 363,934, and released for planting. Two farmers are offering plants of this variety for sale. Circular No. 70 of the Tennessee Experiment Station gives a full description of the variety, its breeding and history. A number of crosses containing one-eighth *Rubus kuntzeanus* were made in the hope of securing a better recombination of certain characters. Promising early-ripening seedlings are not plentiful up to the present time. A study of dessert quality was started with E. K. Weathers, of the General Chemistry Department.

FIRE BLIGHT-RESISTANT PEARS

About 50 seedling selections of fire blight-resistant pears fruited, a part of them being at the Mericourt Station. These seedlings indicate that crosses containing one-fourth *Pyrus serotina* have more or less commercial quality in both fruit and plant characters and in ad-

dition are highly resistant to fire blight. A good-sized population of these crosses is now in the orchard, in nursery rows, and in seedbeds. A small population containing one-eighth *Pyrus serotina* is being built up for study.

IMPROVED STRAINS OF PYRETHRUM

Extensive propagation of high-test chemically selected strains of pyrethrum was begun, in cooperation with the Gulf Research and Development Company. Plants were grown from cuttings, as well as from crown divisions. Further work on improvement and handling of this crop has been started.

INHERITANCE IN GARDEN BEANS

Species of beans imported from Asia were hybridized with com-

Fig. 30—A promising selection from the Urd-Asgrow Stringless cross, which has horticultural possibilities.

mon garden sorts in the hope of securing varieties not subject to Mexican bean beetle injury. The Orential forms were used as male parents. Crosses of Urd, an Asiatic species, and Asgrow Stringless Greenpod were found to be compatible, while those of Urd with other varieties of common garden beans were unsuccessful. Selections from the third, fourth, and fifth generations of this cross were tried in the field to determine the amount of injury under conditions of heavy infestation of the beetles. The data indicate that resistance to attacks of Mexican bean beetle is not a dominant character. Some promising selections were made which are to be used in further studies (see figure 30).

FROZEN-PACK FRUITS AND VEGETABLES

An extensive study of fruits and vegetables for frozen pack was started, the Engineering Experiment Station and the Department of Home Economics cooperating. Trial packs of asparagus, peas, strawberries, red raspberries, Boysenberries, sugar corn, cherries, apples, lima beans, snap beans, and spinach were put up. Many varieties were tried out. A large part of this pack is still in the refrigerator.

IRISH POTATOES

Spring conditions were very favorable for good potato yields this year. Cobbler slightly exceeded both Chippewa and Warba in yields per acre. The different certified seed lots of each variety gave nearly equal yields.

Jersey Redskin for fall crop was tested again this year. The early plantings as a rule, produced a large number of tubers with second growth, which, in turn, reduced the market quality. A comparison of new certified Jersey Redskin seed with unrogued seed that had been grown on the Station grounds for 3 years showed the new seed to be far better in yielding capacity.

SWEETPOTATOES

Bunch Porto Rico, a more convenient type of sweetpotato to grow, continues to outyield the regular strain of vining Porto Rico. Porto Morado, a new strain of vining Porto Rico, produced more U. S. No. 1 and U. S. No. 2 potatoes than the parent strain. This strain is gaining in popularity. Nancy Hall outyielded all other varieties.

ORNAMENTAL PLANTS

A large number of chrysanthemum seedling selections from the breeding work of the U. S. Department of Agriculture blossomed. A number appeared worthy of naming, and propagation was started. Seed of vigorous-growing and large-blossomed hybrid pinks were distributed to several hundred farm women. The usual shipment of new and imported flowering plants were put on trial.

TREE FRUITS

The peach orchard was loaned to the Department of Entomology. Plums were entirely destroyed and apples injured by a freeze in April. These orchards have been managed under Korean lespedeza with winter plowing for many years. There has been very little erosion under these conditions, even on steep land. Weed growth usually is a factor in reducing soil losses. Young *Pyrus calleryana* trees showed trunk injury from the sub-zero weather of January, 1939. There was a very small peach crop. Orchard heaters were used in the pear block.

SWEET-CORN STUDIES

Experiments looking to the development of sweet corn varieties suitable for Tennessee have been carried on over a period of years. The study deals with adaptation, culture, and corn ear worm losses. Figure 31 is a general view showing size and vigor of some of the new hybrids.

Fig. 31—A general view of the sweet-corn plot.

HORTICULTURE AT MERICOURT EXPERIMENT STATION

Brooks D. Drain, L. A. Fister, D. M. Bailey, and A. B. Strand

FIRE BLIGHT-RESISTANT PEARS

About 700 pear selections, more or less fire blight-resistant, have been top-worked into trees in the pear block. Some fruited and a large number should fruit within a year or two. Almost no fire blight has

developed, except on an occasional stock tree, indicating high resistance to this disease. It should be possible to select invaluable varieties from this material.

TOMATOES

Tests of optimum planting dates for tomatoes were continued. Results were similar to those of previous years—the early plantings produced the earliest fruits and, in general, gave the best yields.

Variety trials again indicate that Essary, the new tomato variety released by the Station last year, is somewhat superior to other varieties normally grown in this area. Seed of this variety have been issued to interested seed companies.

The use of "starter solutions"—special fertilizer mixtures dissolved in water and applied to the plants at time of field setting—was studied this year. The desirability of using these solutions under conditions existing in this State will be investigated further.

RED RASPBERRIES AND BOYSENBERRIES

The Tennessee Autumn variety of red raspberry is very promising among the everbearing varieties. Both yields and berries are larger than those of St. Regis. The quality of the berries is high and the seeds are relatively small. Boysenberry is a very promising variety of the dewberry type. It should be especially valuable for home use and local markets, and as a frozen pack in locker plants.

RHUBARB

The planting of rhubarb at Mericourt is now more than 10 years old. A considerable part of it has been destroyed by crown rot. The healthy crowns have been saved and the planting discarded.

PYRETHRUM

Pyrethrum has been grown at this Station for 10 years. The crop has done exceptionally well. Plants of the Station's high-test, chemically selected strains have been distributed for several years. The supply of this valuable material has been transferred to the Knoxville Station.

BLIGHT-RESISTANT CHESTNUTS

A number of trees of blight-resistant chestnut are growing and fruiting on the Station grounds. The nuts are of good size and fair quality.

APPLE ORCHARD

A nice crop of fruit was harvested in the apple orchard. Trees

receiving no mineral fertilizer are making very little growth, and many may die. Those injured by fire from the railroad have made a good recovery.

ASPARAGUS

The Station's records of yields and quality of shoots indicate that asparagus is a promising crop in this section. Clay-loam soils give high yields but somewhat shorter shoots than sandy soils. Asparagus is a promising cash crop for frozen pack in locker plants, for local markets, and for home use.

STRAWBERRIES

Strawberry selections from the breeding work at Jackson were fruited. Tennessee Supreme gave a nice yield of high-quality fruit. Several seedlings appeared promising.

IRISH POTATOES

Plantings of irish potatoes could not be made at Mericourt until April 15 because of wet soil. It was found that Cobbler produced better yields under these conditions than Chippewa and Warba. The yield of U. S. No. 1 tubers was low for all three varieties.

Jersey Redskin for fall crops was tested with a view to determining the optimum planting dates. July 1 and July 10 were best this year. June plantings appear to be too early, since a higher percentage of second growth was found in these early plots. A large number of small tubers were found in the July 20 planting.

SWEETPOTATOES

U. S. No. 47,422, a selection of the Porto Rico sweetpotato type from the U. S. D. A. breeding work, produced the greatest number of bushels of U. S. No. 1 and U. S. No. 2 potatoes. Unit No. 1 Porto Rico, a new improved strain, outyielded the common vining type. Bunch Porto Rico continues to be productive and is convenient to grow. Nancy Hall ranked second in production.

HORTICULTURE AT WEST TENNESSEE EXPERIMENT STATION

Louis A. Fister and Brooks D. Drain.

STRAWBERRY BREEDING

Strawberry selection Tennessee No. 260 was named "Tennessee Supreme" and a plant patent applied for. Among numerous selections tried out in freezing tests, it was outstanding. Some growers in the State applied for contracts to grow and sell plants of this new variety.

From 4,500 seedlings that fruited for the first time in the spring, 230 selections were made. These seedlings will be tried, in 30-foot

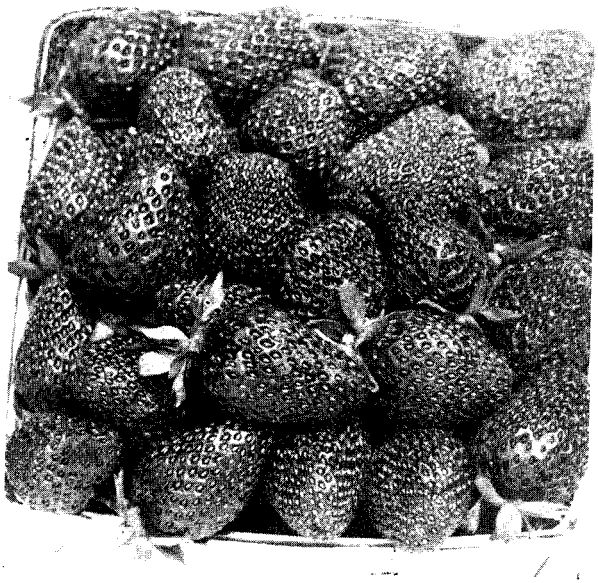

Fig. 32—A quart of Tennessee Supreme strawberries. Good production, large berries, attractive color, and high quality recommend this variety for trial.

rows, along with standard varieties and the Station's better selections of the past few years.

Tennessee No. 148 has shown up unusually well in shipping tests, and its uniform fruit is very attractive. The selection is a medium plant-maker, and therefore has slightly larger individual plants than Blakemore. The better spacing probably accounts for the fact that Tennessee No. 148 maintains its size throughout the fruiting season. Growers are testing its adaptability to different sections.

PEACHES

The severe freezes of January killed the fruit buds in the peach orchard at Jackson. Temperatures as low as 15 degrees below zero were recorded at the Station. The new planting of varieties set in the spring made good growth.

APPLES

Lodi again showed great promise as an early apple. It is larger than Transparent and is excellent for sauce. Its large size and yellow skin make it very attractive. Some 8-year-old Staymareds produced 2 bushels of large, well-colored apples per tree. The flavor of this red sport of Stayman is even better than that of its parent.

Fig. 33—A planting of Tenneessee No. 148 strawberry.
This new seedling, developed in the Station's breeding work, appears very promising.

SWEET CORN

A good yield of high-quality sweet corn was obtained from the planting of newer varieties and hybrids, indicating that good sweet corn can be produced in West Tennessee. A planting was made May 6, and harvesting of the earliest varieties was started July 17. This test was located on poorly drained soil, and hence was slow in maturing. Tennessee Sweet Hybrid was outstanding in total number of salable ears per acre. It matures about the time of Golden Cross Bantam. It is a white corn with some yellow kernels and has a larger ear than Golden Cross Bantam. It is of the Stowell Evergreen class. Burpee Cross and Marcross were the earliest-maturing varieties in the test. Stowell Evergreen has ranked above the Stowell Evergreen Hybrid in the trials at Jackson. The former produced at the rate of 11,140 ears per acre, and its hybrid only 5,200 ears per acre.

SWEETPOTATOES

Late-set sweetpotatoes made a good growth and produced very nice marketable potatoes. The 3 leading varieties made the following

yields of U. S. No. 1 grade: Nancy Hall, 196 bushels; Bunch Porto Rico, 127 bushels; Vining Porto Rico (Unit No. 1), 115 bushels.

FREEZING TEST

Varieties of fruits and vegetables were frozen, packed, and stored in a locker plant. Pint and quart containers were used. Small fruits frozen in a sugar pack or with sugar sirup were better-flavored than the no-sugar pack. Tendergreen and Stringless Greenpod snap beans were more tender than Bountiful. The snap beans were processed dry. Sweet corn was packed in a very weak brine solution (teaspoon salt to 1 quart water). All varieties in the test were high-flavored. Stage of maturity, however, is important in harvesting and grading fruits and vegetables for freezing. Some samples of sweet corn were too starchy because they were left on the stalks too long.

MARKETING

Harry Carlton

The marketing studies of the frozen-food and other food-processing industries which were started in 1935 were continued through 1940.

Active commercial strawberry-freezing operations were carried on by a grower's cooperative in Cleveland, two commercial packers in Portland, and a commercial packer in the Humboldt area. While there are no accurate figures available, it is estimated that well over 1,000,000 pounds of strawberries were marketed in frozen form. Generally the packers will come into the market when the price has dropped to about $1.50 per crate, thus in effect putting a base under the market at this figure—a profitable price for the grower, particularly as he does not have to provide a shipping crate.

The installation of freezer-locker plants continued to expand during 1940. At the end of 1939, Tennessee had 13 plants installed, which had increased to 25, installed and under construction, by the end of 1940—an average of a plant per month during the year.

A survey of 21 Tennessee Plants on December 1 showed that they had 5,491 lockers installed and 3,979 rented. The rented lockers were divided as follows: Farmers 1,721, urban renters 2,258. The installed lockers were divided according to areas as follows: East Tennessee 816, Middle Tennessee 2,551, and West Tennessee 2,124.

There was a pronounced tendency toward the installation of smaller plants in the small rural trading centers which should increase the percentage of lockers used by our farm population.

According to the best information obtainable, the Tennessee locker renters were quick-freezing over 2,250,000 pounds of their home-pro-

duced food per year. In addition, many of the operators of these plants were purchasing local products for processing and sale through the locker plant. The products of both operators and renters, particularly fruits and vegetables, were generally well packaged and in excellent condition.

Agricultural Experiment Station Bulletin No. 168, "Home Preparation of Fruits and Vegetables for the Freezer-Locker," first published in January, 1939, was revised and reprinted in May, 1940. It continued its wide distribution to both farm and city locker renters in Tennessee and in many other states, and is of material assistance in the preparation of products for preservation in the freezer-locker.

The report, "A General Survey of the Frozen-Food Industry," which was completed in the latter part of 1939, was re-written and condensed for publication as an Agricultural Experiment Station bulletin and as a basis for the book, "The Frozen Food Industry," to be published and bound by the University of Tennessee Press.

Based on our market studies, the following estimates were made of the production volume of quick-frozen foods for the institutional and retail trades of the United States in 1939:

	Pounds
Fruits and vegetables	290,000,000
Seafoods	45,000,000
Poultry	10,000,000
Meats	5,000,000
Total	350,000,000

This represents an increase of approximately 100,000,000 pounds over the 1938 production by the commercial packers, nearly all of which was accounted for by the increase in the frozen-fruit and -vegetable pack. The above figures do not include quick-frozen foods packed in the freezer-locker plants of the country—estimated at well over 400,000,000 pounds during 1940.

At the request of the Agricultural Extension Service of the Virginia Polytechnic Institute, a brief survey of the apple and peach situation in the Crozet, Virginia, area was made and plans for marketing through frozen-food channels were begun and discussed with the members of the local growers' cooperative. This later resulted in the installation of a combined commercial fruit-freezing and freezer-locker plant.

In addition to articles concerning frozen foods, prepared for publication in the trade press, papers were presented at frozen-food meetings in various parts of the United States.

PHYSICAL PROPERTIES OF COTTON

K. L. Hertel

The study of the relation of physical properties of textile fibers to the properties of yarn and fabrics has been continued, with particu-

lar emphasis on yarn strength. A simplified theory of yarn structure has been developed which indicates, tentatively, how the factors of fiber length, fiber surface per gram, fiber strength, and coefficient of friction, along with the variability of these factors, enter into the production of yarn strength. The values of optimum twist multiplier predicted by this theory are in good agreement with published values, although not enough data are available yet for an accurate test of the comparison.

MEASUREMENT OF LENGTH

The new design of fibrograph, mentioned in last year's report, has been tested further, and the pen arrangement has been improved. Five instruments have been built. They are in use at the cotton laboratory, University of Tennessee; Oklahoma A. & M. College, Stillwater; Georgia School of Technology, Atlanta; U. S. Rubber Company, Hogansville, Georgia; and Agricultural Marketing Service, U. S. D. A., Washington, D. C. An instrument is soon to be sent to U. S. Cotton Field Station, Shafter, California.

A study of the effects of humidity and temperature on fiber lengths, as measured by the fibrograph, has been carried out. In this study it was found that the measured lengths were slightly greater

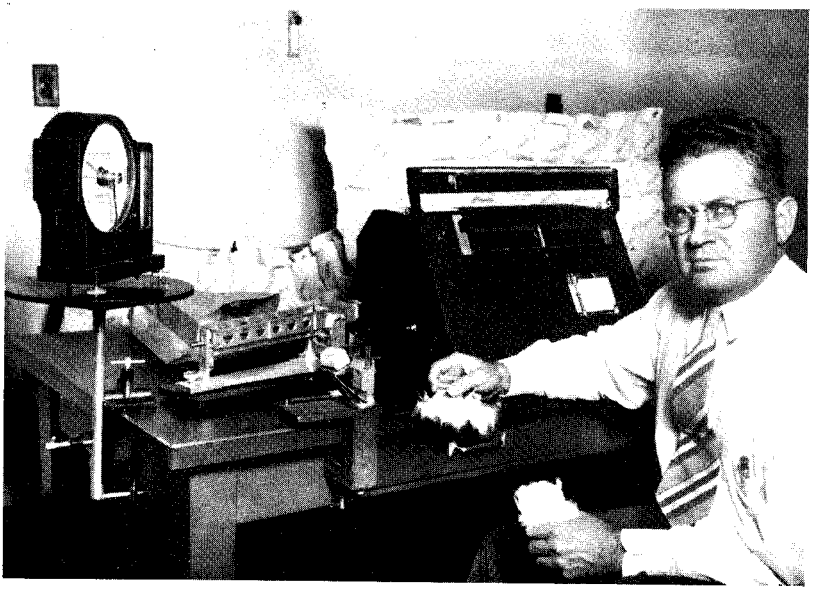

Fig. 34—Dr. Hertel and his fibrograph.

at the higher humidities for a given temperature, and also at the higher temperatures for a given humidity. The sampling error for the measurements appeared to be less under standard conditions (70° F., 65% R. H.) than at other combinations of temperature and humidity.

FINENESS MEASUREMENT

An instrument, tenatively termed an "arealometer," has been built for making routine measurements of the surface area per gram mass of fiber (fineness) for cotton fibers. This instrument has been extensively tested and found to have a low standard error of measurement (about 2%) and to be capable of measuring about 50 samples per operator per day. Interest in the instrument and its results is evidenced by the fact that men from several laboratories have sent in samples of cotton for which they desired fineness measurements. The construction of an improved model of the instrument is being considered.

FIBER TESTING LABORATORY

The laboratory has made length and fineness analyses on 5300 cottons during the year, of which 1200 were for persons outside the University. These tests have met a great need in the region, and as a result The University of Tennessee Research Corporation is contemplating the establishment of a laboratory designed to make the testing service available to everyone on a fee basis.

PLANT PATHOLOGY

C. D. Sherbakoff

Studies were conducted during the year by the Plant Pathology Department on projects previously initiated. Most of the work was done at Knoxville, by the writer, with the assistance of Dr. R. A. Hyre on the new-fungicides and tomato-leaf-spot projects, and of other members of the Department on other projects. Dr. M. C. Richards was in charge of work on various projects at the West Tennessee Experiment Station, Jackson; while Mr. Dennis H. Latham, at Springfield and Clarksville, devoted his entire time to tobacco diseases.

FUSARIUM WILT OF ECONOMIC CROPS

Watermelon.—Varieties of watermelon were tested for *Fusarium*-wilt resistance in three fields near Jackson. Results were similar to those previously obtained in a test near Knoxville, indicating high wilt resistance of Hawkesbury. This variety has produced satisfactory yields of fruit of medium size and fair quality, and is deserving of small-scale tests by growers.

Tomato.—Studies of tomato wilt consisted primarily of green-

house and field tests of various tomato segregates obtained from crosses between the wilt-immune line of cherry tomato—*Lycopersicon pimpenelifollium* x certain horticultural varieties which were developed by and obtained from Dr. C. M. Tucker, of the Missouri Experiment Station. The best segregates will be tested further for wilt immunity and fruit quality, and the most promising ones used for further improvement of horticultural varieties that have proved best in certain localities.

Cotton.—Studies of cotton wilt were conducted in cooperation with the Division of Cotton and Other Fiber Crops and Diseases, U. S. Department of Agriculture. They consisted in (1) further tests of pure-line isolates of the *Fusarium* causing cotton wilt, to determine their ability to cause the disease in different varieties of cotton; and (2) regional wilt tests in the field at Martin and Tiptonville. The regional tests are carried under the same plan, and with the same varieties of cotton, by all experiment stations growing primarily upland cotton. This season there was not enough wilt at either Martin or Tiptonville to make the data of much value. Yields of given varieties in the two localities were strikingly different, however, for certain of the varieties. Coker's 4 in 1 made the highest yield at Tiptonville, while at Martin it was next to the lowest. Miller 610 was the highest at Martin, but next to the lowest at Tiptonville. These results, together with those of preceding years, show that the difference is more than a seasonal one, or a chance variation, and thus prove the important effect of soil type on relative yields of different varieties of cotton.

WHEAT ROOT ROT AND SCAB

Work on wheat root rot and scab was limited to a continuation of the selection and breeding of wheats found locally to be somewhat tolerant to these diseases. The aim was (1) to find among them the highest-yielding lines, and (2) to incorporate into them stem- and leaf-rust resistance, by crossing the wheats with varieties found to be rust resistant. Several of the latter were obtained in 1937 from the Division of Cereal Crops and Diseases. Though the varieties are not suitable for local culture, they are extremely valuable in breeding. Of these, Supreza, Hope x Hussar, and Ceres x H44 were most extensively used.

Of the older selections, No. 2 is being increased at the Columbia Experiment Station, to be released to growers later as "Blue Stem 2." This is a beardless, early wheat suitable for most of the State—from Knoxville westward—on good land. When grown on poor land its kernel is small and not readily accepted by millers.

The other selection, No. 612, had been increased and released through the Tennessee Crop Improvement Association as "Fulcaster 612." In appearance the wheat is the same as common Fulcaster, but

it is more uniform and makes considerably better yield, especially east of Knoxville. The wheat is bearded, and produces a good sample. On rich land, however, it is subject to moderate lodging.

Over 600 selections from F_2, F_3, and F_4 generations of the crosses between our best soft winter wheats by various leaf- and stem-rust-resistant wheats are being grown in a 2-acre field near Knoxville.

STRAWBERRY BLACK ROOT

The work with strawberry black root consisted in further testing of black root-tolerant selections from various seedlings and crosses at Knoxville and Portland. Up to the present time the tests have been on too small a scale to admit of definite conclusions. Several of the lines, however, are being grown at Portland on a large enough scale, and with sufficient repetition, to promise the information next season. Further selfing and crossing were done on the more promising lines, including breeding material from the New York (Geneva) Experiment Station. From 83 of the selfs and crosses, 2940 potted plants are growing in the greenhouse, for field planting next March.

TOMATO LEAF SPOT, OR BLIGHT

Tomatoes in Tennessee are seriously damaged by certain leaf spots, usually by the spot due to the fungus *Alternaria solani*. Systematic search for a cultivated variety of tomato possessing a definite degree of resistance to the fungus has met with no success, even though a large number of most promising standard varieties, special selections made by other workers, and many of our own selections and crosses have been tried here for several years. This year the tests were carried out with over 180 apparently disease-tolerant selections, but none showed definite resistance. There appears to be a slight degree of difference, however, in the amount of damage caused by the disease on some of the tomatoes.

Certain spraying and dusting tests with various fungicides were carried out at Dandridge, Knoxville, and Jackson. At Dandridge, all of the fungicides used gave significant control of the disease. No important yield increase was obtained from any of the treatments, though the treated plots did yield slightly more than the check. Early blight spots per terminal leaflet following various treatments were as follows: Neutral bordeaux mixture plus MgO, 5.1; Yellow Cuprocide sprays, 6.2; copper-lime dust, 9.1; Tennessee "34" spray, 9.2; Yellow Cuprocide-Celite dust, 9.3; basic copper arsenate-Tennessee "34" spray, 9.3; Tennessee Copper Dust, 10.3; unsprayed, 14.6. Since part of the field was drowned, no conclusion could be reached in regard to the yield differences.

Data on the results of spraying and dusting with different fungicides at Knoxville and at Jackson were of no value because of the

late appearance and unimportance of the disease. In this connection it should be stated that the seed was obtained, either by ourselves from clean fruit, or from very clean commercial stock properly disinfected. The plants were raised in clean washed sand in the greenhouse and planted in the field free from trash. The field was not in tomatoes or irish potatoes during the preceding season. The conditions apparently gave practical control of the disease. Previous studies of other workers, especially those of the late Dr. Pritchard, indicate that for the time being, when no commercial variety resistant to the disease is available, we must depend on sanitary measures. Seed should be disease-free and plants raised in a disease-free soil. Plants should be set out in fields plowed clean the preceding fall, and on ground that has not grown tomatoes or potatoes for several years, since both crops are susceptible to this disease.

NEW FUNGICIDES

Studies of new fungicides, conducted by Dr. Hyre, consisted primarily in (1) testing of some eradicant sprays, in cooperation with Mr. J. O. Andes, at that time pursuing post-graduate work at the University of Wisconsin; and (2) testing of various "insoluble" copper fungicides, in search for an effective material to spray Golden Delicious apples, which are severely injured by spraying with either standard bordeaux mixture or lime-sulphur.

The eradicant sprays consisted of bordeaux mixture plus calcium and zinc arsenates and, in one case, Elgetol. Fish oil was used as a sticker. Against bitter rot of Black Ben apples near Dandridge the addition of the eradicant sprays gave no increased control over the standard schedule of bordeaux sprays, either at spray-schedule strength or at half that strength. In an apple-blotch experiment, near Dayton, the eradicant spray alone gave significant control of the disease, but not as good control as the summer sprays of Tennessee "34" copper fungicide without the eradicant spray. The combination of the two was not appreciably better than the summer sprays alone.

To reduce bordeaux injury on Golden Delicious apples, tests were made of an "insoluble" copper fungicide (Yellow Cuprocide) and of two neutral bordeaux mixtures, one safened with magnesium oxide and the other with wool grease. The Cuprocide, at 1½ pounds to 100 gallons, gave the most severe injury; the two neutral bordeaux mixtures gave severe, but slightly less, injury than the standard 8-12-100 bordeaux. There was not enough bitter rot present to admit of worth-while counts on disease control.

Results of different fungicide sprays on tomatoes are given above, in the discussion of tomato leaf spot.

RED-CLOVER BREEDING

Breeding of red clover this season consisted in getting in-

bred seed from 18 different lines obtained in the course of previous work. The method employed was that of covering with a wire cage a fairly large group of plants of each line. Bumble bees were introduced into the cages daily. Many hand crosses of bagged flower heads were obtained from the most promising individual clover plants of the best lines.

From seed of caged plants, over 25,000 potted plants are being grown. These will be used next spring for seed increase in isolated fields around Jackson. Plants from hand-crossed seeds are also grown in pots for planting at Knoxville, for further studies. The object is to secure disease-resistant red clover of uniform seed color and plant appearance, for identification of the varieties when released. It is expected that this object will shortly be attained. A number of lines already are fairly homozygous for the characters.

TOBACCO WILDFIRE

Studies of tobacco wildfire were conducted by Mr. Dennis H. Latham in the sections around Springfield and Clarksville. While the studies were concerned mainly with wildfire, some other important diseases were given attention, to prepare the ground for a study of dark-tobacco diseases.

To provide information as to time and place of appearance of wildfire and the efficiency of recommended methods for its control under Middle Tennessee conditions, about 30 seedbeds, 50 square yards each, were located at various places scattered throughout four counties. The plan was to treat the beds at such time and in such manner as was thought necessary for control. In every case the cooperator prepared the seedbed by his own method and seeded it with his own seed, so that a test block of at least half an acre could be planted in the field for observation during the growing season. The Experiment Station furnished a new canvas for each of the test beds. A spray program using 4-5-50 bordeaux was carried to completion on all but one of the beds. The plants were also sprayed with Cuprocide and S. E. C. oil in an attempt to control downy mildew. Although wildfire was extremely common and injurious in many fields the preceding season, frequent examination failed to show it in any of the test beds until the plants were ready to be set in the field. Only one bed gave definite evidence that bordeaux had controlled wildfire. In this case the disease was not evident on any plant in the test bed, while in the cooperator's three beds, located along the side and ends and within 5 feet of the test bed it was well distributed. At the time plants were set out, this case was expected to afford an excellent demonstration of control; but extremely dry weather prevented development of wildfire in the field, even on plants from the bed in which it was generally present.

In addition to the spraying tests, a number of tests in Robertson

and Montgomery Counties were run on several strains of mosaic-resistant dark-fire-cured tobacco. Three strains of black shank-resistant tobacco were planted in the fields at one locality to determine the type of growth the plants would make. The mosaic-resistant and the black shank strains were obtained from Dr. Clayton, of the U. S. Department of Agriculture. Only partial data are available on these strains.

All strains resistant to both mosaic and black shank were back crossed on Madole tobacco in an effort to improve their agronomic characters.

MIDDLE TENNESSEE EXPERIMENT STATION

Columbia

L. R. Neel, Superintendent

WEATHER

Rainfall for the year 1940 was 43.77 inches—22.93 inches the first six months and 20.84 inches the second six months. It was a few inches below normal and was rather poorly distributed; there were heavy, wasteful rains in some months and a very light fall in other months. On the whole, it was an unfavorable growing season for pastures.

LIVESTOCK

Winter pasture versus silage feeding, and the pasture irrigation project with dairy cattle, reported in 1939, were continued.

The all-year pasture maintenance and finishing experiment with beef cattle on bluegrass pasture and hay from the same field, and the alfalfa hay and bluegrass experiment, reported last year, are still in progress. A grain-on-grass experiment with beef cattle, and a fattening experiment where sorghum-corn silage is contrasted with good alfalfa hay, were carried through the year. The work should be completed and results compiled in 1941.

The experiment with sheep, comparing ewes from the Northwest and the Cumberland Mountains and ewes produced at the Experiment Station, was begun in 1939 and will be continued at least through several more years. Production of lambs and wool and length of life of ewes will be compared.

TOBACCO

Eight varieties were used in the burley-tobacco test in 1940. Greeneville No. 8 led in pounds per acre and in money income. Judy's Pride was second and Johnson's Root Rot Resistant was third.

As usual, the fertilizer test was inconclusive. Always stable manure or a nitrogen fertilizer increased the yield more or less and

increased money income per acre, although the increase was not very great on sod land. The value of potash and phosphate fertilizers again seemed doubtful.

SOYBEANS

A variety test was made with soybeans to determine the standing of the best varieties in producing soybeans for the oil mills. Yields were very low because of unfavorable late-summer and early-fall weather. Mamredo led, with Volstate, Ogden, Clemson, No. 276, and Macoupin following in the order named.

In yield of hay, the varieties ranked as follows: Ogden, Volstate, Mamredo, No. 276, and McCoupin. (Clemson was not included in the hay test).

In a rate-of-seeding test with No. 276, planted in 29-inch rows, 15 pounds of seed per acre gave a yield of 10.4 bushels; 30 pounds, 8.3 bushels; 60 pounds, 7.2 bushels; and 90 pounds, 8.1 bushels.

In the spacing test, No. 276, planted at the rate of 40 pounds of seed per acre, in 35-inch rows, gave a yield of 10.6 bushels; planted in 28-inch rows, 9.9 bushels; in 21-inch rows 7.4 bushels; and 120 pounds of seed per acre, drilled in 7-inch rows and not cultivated, produced 6.3 bushels.

VARIETIES OF SMALL GRAIN

The yields of varieties of barley grown in 1940 were: Polders, 64 bushels; Kentucky No. 1, 63; Tennessee No. 52, 56; Smooth Awn B5-9S, 55; Smooth Awn B5-14, 47; Missouri Beardless, 45; Tennessee Beardless No. 5, 45 bushels.

Yields of winter oats were: Tenn. 092, 45 bushels; Fulwin, 43; Lee, 43; Tennex, 42; Fulghum, 37; Winter Turf, 35; Fulgrain, 29 bushels. In a 3-year average, Tennex leads in yield.

Yields of wheat for the year were as follows: Nabob, 36 bushels; Tennessee No. 2, 35; Fulhio, 34; V. P. I. No. 131, 34; Trumbull, 33; Nittany, 33; Gladden, 33; Tennessee Selection No. 64, 33; Forward, 32; Wabash, 32; Mammoth Red, 31; Currell Prolific, 30; Leap Prolific, 30; Dixie Purple Straw, Gasta, and Early May, 23 bushels each; and Red Hart, 21 bushels.

SOURCE OF COBBLER POTATO SEED

The season was unfavorable, and Cobbler potato seed produced on the Cumberland Plateau yielded only 61 bushels per acre; Main Cobblers, 78 bushels; and Red River Valley Cobblers, 87 bushels. The average yields for 6 years were somewhat higher, but the order of yields of seed from the different sources was the same as in 1940.

NEW PLANTS TESTED

Chia, a new plant, was grown with inconclusive results. Alyce

clover was late in germinating, and growth was unsatisfactory, but conclusions as to the value of this crop will come later. Lappacea clover also was grown in the test plots, but either it did not make a typical growth or it is not adapted to this section. Michael's grass was sown in the fall for winter pasture and will be reported on later.

WEST TENNESSEE EXPERIMENT STATION

Jackson

Ben P. Hazlewood, Superintendent

The West Tennessee Experiment Station is located one mile west of Jackson, Madison County, with south entrance on U. S. highway No. 70 and northeast entrance on State highway No. 20. The average annual rainfall in this locality over a period of 35 years, from 1898 to 1932, was 47.96 inches. The average date of last killing frost in the spring, for 38 years, was April 3; average date of first killing frost in the fall, October 24. The elevation is 400 feet above sea level.

This Station was established in 1908. It comprises approximately 200 acres, of which nearly 150 acres are in clutivation; the remainder is in roads, building sites, woodland, and permanent pasture. The following soil types occur: Calhoun silt loam, Olivier silt loam, Lintonia silt loam, Waverly silt loam, Collins silt loam, Vicksburg silt loam, Cherry fine sandy loam, and Concord fine sandy loam. Research work was begun in 1909. The Station is directly concerned with the solution of problems relating to West Tennessee farming. Investigations under way relate to livestock, field crops, and fruits and vegetables.

WEATHER CONDITIONS

Rainfall for the year 1940 was below average (38.58 inches). The distribution favored the principal crops grown in West Tennessee, but hindered the planting of winter crops, interest in which has expanded greatly in recent years. Rainfall for the 2 months of September and October was only 1.90 inches. January was one of the coldest months since 1918. For only 3 days was the minimum temperature above freezing. The mean maximum for the month was 34°, mean minimum 15°. The lowest temperature recorded was 15° below zero. A light covering of snow accompanied the lowest temperatures. Cold weather caused little damage to field crops.

WINTER CROPS

Barley.—Tennessee No. 52 barley, a selection from Union, has been grown in comparison with Missouri Beardless and Polders for 3 years, and Kentucky No. 1 for 2 years. Table 28 gives average dates of harvest and acre yields.

TABLE 28—*Comparative dates of harvest and yields of Tennessee No. 52 and three other barleys.*

Variety	Average date of harvest	Acre yield
		Bushels
Tennessee No. 52	May 30	65
Missouri Beardless	May 30	46
Polders	June 8	56
Kentucky No. 1	June 3	56

Barley and Soybeans Versus Barley and Lespedeza.—The practice of seeding lespedeza in barley during the month of March has been compared with the seeding of soybeans in barley with a grain drill about the first of April. Tennessee No. 52 barley, Korean lespedeza, and Tokio soybeans are the varieties of crops used. Work at Knoxville indicates that Laredo soybeans would have given better results under the conditions of this test than Tokio. Table 29 gives the barley and hay yields for each year of the test.

TABLE 29—*Yields of barley and hay.*

Year	Barley	Soybeans	Barley	Lespedeza
	Bushels	Tons	Bushels	Tons
1938	18	.72	18	.58
1939	14	2.08	15	1.14
1940	26	1.31	20	.61
Average	19	1.37	18	.77

Spring Oats.—Several varieties of spring oats have been grown in comparison with Kanota, a standard variety known to be well adapted to West Tennessee. The increase in yield for several varieties over Kanota is shown in table 30.

Winter Oats.—The three new varieties of Tennessee winter oats have been grown in comparison with Virginia Gray Turf for 5 years.

TABLE 30—*Increase in yield of four varieties of oats over Kanota.*

Variety	Years grown	Increase
		Bushels
Tennessee 092 [1]	1	8
Brunker	2	8
Trojan	2	1
Columbia	2	4

[1] A winter-hardy selection from Fulghum.

The average yield of each variety for the 5 years 1937-1941 is shown in table 31.

TABLE 31—*Comparative yields of Virginia Gray Turf and three other varieties of oats.*

Variety	Average acre yield
	Bushels
Tennessee 092	73
Tennex	69
Fulwin	67
Virginia Gray Turf	56

Cover Crops.—Crimson clover, hairy vetch, Austrian winter peas, Early Southern (Giant) bur clover, Italian ryegrass, and Balbo rye were used as winter cover crops. It is interesting that the severe winter conditions of January did not result in loss of stand of any of these crops.

VARIETIES OF CORN, SOYBEANS, AND LESPEDEZA

Corn.—Jellicorse was used as a standard of comparison. Tennessee hybrids No. 3, No. 10, No. 13, No. 15, and No. 16 exceeded Jellicorse in yield from 1 to 4 bushels per acre when planted on rich land. Funk hybrids G46, G84, G125, G135, G167, and G244 were planted in comparison with Jellicorse on rich land. None of these strains equaled Jellicorse in yield.

Soybeans.—Macoupin, Arksoy, Ogden, and Volstate are new varieties which gave greater seed yields than the standard variety, Tokio. Arksoy and Macoupin mature in September and Volstate and Ogden in October. Clemson, Missoy, Palmetto, Charlee, and Douglass yielded much less than Tokio.

Lespedeza.—Four varieties of lespedeza—Tennessee No. 76, Kobe, Korean, and common—were grown from 1927 to 1935, inclusive. Both hay and seed yields were noted. Table 32 shows average yields for each variety:

TABLE 32—*Hay and seed yields of four varieties of lespedeza.*

Variety	Acre hay yield	Acre seed yield
	Tons	Pounds
Tennessee No. 76	2.54	234
Kobe	2.28	222
Korean	1.75	264
Common	2.17	210

Dates of Planting Cotton and Corn.—Cotton and corn have been planted for the period 1933-1940 at 6 different dates each year. The first planting of both crops has been in early April, followed by 5 later plantings at intervals of approximately 2 weeks. The plantings were repeated 3 times each year.

TABLE 33—*Average yields of cotton for each of six planting dates,* 1933-40.

Average date of planting	Average acre yield, seed cotton
	Pounds
April 4	844
April 16	1161
April 30	1128
May 13	979
May 26	678
June 8	440

TABLE 34—*Average yields of corn for each of six planting dates,* 1933-40.

Average date of planting	Average acre yield
	Bushels
April 4	32
April 16	33
April 29	31
May 13	30
May 26	27
June 8	23

LIVESTOCK

Livestock work includes pasture study with hogs, sheep, and dairy cattle, and winter feeding of steers.

A breeding flock of Hampshire sheep and a breeding herd of Jersey cattle are maintained with only roughage and pasture feeding. Both the sheep and dairy cattle appear normal after several generations of each have been fed in this way.

Crimson clover silage has proved satisfactory. The third year of a test comparing crimson clover silage with corn and sorghum silage is under way. It seems to be slightly superior to corn and sorghum silage in the fattening ration for steers and as a feed for dairy cattle. The crimson clover has been cut for silage in the early bloom stage. A combination of molasses and phosphoric acid has been used as a preservative.

Dehydrated sweetpotatoes, when used to replace corn-cob-shuck meal in a fattening ration for steers, have been satisfactory. The economy of the ration has not been determined, since the cost of dehydrated sweetpotatoes has not been definitely established.

TOBACCO EXPERIMENT STATION

Greeneville

Frank S. Chance, Superintendent

The Tobacco Experiment Station, located 5 miles south of Greeneville, Tennessee, near the Nolichucky River, was established in 1932,

the purpose being the study of burley tobacco production. This study includes:

1. Fertilizer requirements on different types of soil.
2. Cropping tests.
3. Curing methods.
4. Tests of different strains for resistance to black root rot.
5. Producing of new strains with high quality and resistance to black root rot.
6. Cultural methods.

In 1935 additional lands were acquired and projects were set up for the study of a broadcast system of farming. This study includes:

1. Barley and oats as a substitute for corn.
2. Crimson Clover and winter grasses for grazing.
3. Adaptability of various grasses to the soils and climate of East Tennessee.
4. Measurement of erosion losses as affected by different cropping systems.
5. The making of silage from sericea and alfalfa, and the comparative value of silages from these two crops in the feeding of steers.

FERTILIZER REQUIREMENTS OF BURLEY TOBACCO

Data accumulated during past years on the fertilizer plots indicate that much progress has been made in determining the burley tobacco plant's need for both nitrogen and potash. The requirements are much higher than fertilizer manufacturers have recognized in making up their formulas for tobacco.

These studies have demonstrated the value of barnyard manure in both quantity and quality production. They have also demonstrated that its use encourages the development of black root rot, even in rotations where tobacco is grown only once in 3 years and no legumes are sown. It would seem, moreover, that where as much as 10 tons of manure per acre is used, the addition of potash in the commercial fertilizer is of little value, and that where as much as 15 tons of manure is used, the addition of potash may retard plant growth to a marked degree and only slightly improve the quality of leaf.

As much as 18 pounds of nitrogen per acre can be used to advantage in connection with barnyard manure, even where 15 tons of manure is used. Where only 18 pounds of nitrogen and 42 pounds of P_2O_5 are used per acre, the results from potash, at rates ranging from 30 to 240 pounds of K_2O per acre, are very conflicting. It appears that where no more nitrogen and phosphate are used than the above-mentioned amounts, there are no consistent returns from the use of more than 60 pounds of K_2O per acre. The data also indicate that potash from a sulfate source is most desirable.

CROPPING TESTS

Cropping tests have been in progress for 7 years. In the 2-year tests, some outstanding differences have begun to appear, especially where crimson clover and hairy vetch have been used. The corn and tobacco plots produced an average of only 535 pounds of leaf in 1940, and that was of inferior quality. On the other hand, the hairy vetch plots produced an average of 1364 pounds of good-quality leaf, while the crimson clover plots produced 1224 pounds of fair-quality leaf. The soybean-tobacco rotation is beginning to give better results in both pounds and quality than the cowpea-tobacco rotation. The fallow-weed plots and the rye-weed plots are producing good leaf of about the same quality, but neither combination is yielding as many pounds per acre as the hairy vetch or crimson clover plots.

CURING

Tests running over a period of 7 years have not indicated that there is any great difference in the quality of leaf obtained from scaffolding tobacco in the open for a week or ten days and putting it in the curing barn as soon as it is wilted after cutting.

The very low temperature during the 1940 curing season demonstrated forcibly the effects of low temperature on burley while in the curing stage. Barn temperature below 50° for a few nights immediately following the housing of tobacco caused much of it to have a greenish cast. When these low temperatures came after the tobacco had yellowed and before it had reached the proper color, many of the leaves showed spots of lemon color, as if it had been flue-cured.

In the curing-test barn, the night temperature was kept about 2½ degrees higher by the addition of artificial heat to one end of the barn. The percentage of lemon-colored tobacco was slightly less in the end where heat was applied than in the control end.

NEW STRAINS OF BURLEY

Many of the less desirable varieties and strains of burley that have been tested in past years were left out of the variety-test plots in 1940 and new strains were added. Some of the new strains gave excellent results on soils known to be heavily infested with black root rot and also on soils relatively free of the organism.

In addition to tests conducted on the Station farm, 12 of the most promising strains and varieties were grown on 9 cooperating farms. Out of these tests, some of the new strains produced at the Station proved to be significantly better in quality than any of the varieties that have been grown in the past.

CULTURAL METHODS

Many tests have been made on cultural methods, such as height

of topping, plant spacing, tillage, and the difference between splitting the stalk for housing and putting it on the stick by means of a spear.

These studies have shown that for best results burley should be topped, and that plants from 12 to 15 inches apart, in rows 3½ feet wide, is probably the most practical spacing. Results indicate that the crop is injured by deep cultivation after it is 18 inches high, and that horse-drawn tools are not necessary if grass and weeds are controlled by the use of a hoe. Putting plants on the stick by means of a spear has not always proved best, but it saves labor and gives about the same results as splitting the stalk.

BROWNTOP MILLET

After crimson clover seed was harvested from a 14-acre field in the summer of 1940, the field was prepared and sown to temporary pasture: 7 acres to Sudan grass and 7 to browntop millet. Cattle were turned on the pasture the first day of August and kept there throughout the month. Cattle grazing on millet made a group gain of 1045 pounds, and the same number of cattle grazing Sudan grass made a group gain of 930 pounds. The two halves of the field were separated by an electric fence. Cattle on Sudan grass were observed reaching under the fence to graze the browntop millet, while those on millet did not reach under for the Sudan grass.

SILAGE TESTS

Forty head of steers were put on a silage-feeding test. Half of these steers were on silage made of alfalfa and half on silage made of sericea. They were fed from a battery of 8 silos, 4 filled with alfalfa and 4 with sericea. Different preservatives were used with the silage to determine the quality of feed made. Results indicated that very satisfactory silage can be made with either blackstrap molasses or phosphoric acid as a preservative for alfalfa, and that phosphoric acid should not be used as a preservative for sericea. Both alfalfa and sericea made very good silage where no preservative was used.

LAND PURCHASE

Fifty-four and one-half acres of land was purchased during the year. This tract joined the Station on the northeast side. It is to be used largely for grazing.

WEATHER

The winter was cold and dry. The drouth continued until the latter part of June. Through July and August there was an abundance of rain and the crops were very good. Pastures suffered more from the drouth than any of the other crops. Rain gauges are main-

tained at two places on the farm. One gauge registered 35.73 inches precipitation for the year and the other registered only 31.59 inches.

LIBRARY

Sarah C. Currell

The Experiment Station library has expanded its services during the year primarily through increase in the number of books, bulletins, and periodicals. The Station library added to its collection 237 books, the library of the College of Agriculture, 395 books, an increase over last year of 632 volumes. The agricultural libraries now have a total of 19,217 volumes. This does not include the bulletins and periodicals that have never been catalogued. As an illustration, 1,305 uncatalogued bulletins were added to the circulating file. These two libraries are housed in the same room, serving both Station and College.

The librarian has three student assistants, who work from 12 to 13 hours each per week. Two of the assistants are paid by the NYA, the third is employed by the Station. These students help with routine work, such as circulation, shelving books, filing, typing, and sorting material.

The Station and College libraries circulated during the year 4,146 bulletins and periodicals. This does not include books used in the room or charged out for overnight. There were 10,525 reserve books circulated.

Bulletins are received from the forty-seven other state experiment stations; the experiment stations located in Alaska, Guam, Hawaii, Porto Rico, and the Virgin Islands; a number of foreign experiment stations, and the United States Department of Agriculture. Material is also received from state departments of agriculture. The Station library in 1940 received 115 current periodicals; the College library, 162. On account of the war, many of the foreign periodicals have ceased to come. Some of these are subscribed for; others are either donations or exchanges. A large number of these bulletins and periodicals are bound. During the year, 144 volumes have been prepared for the bindery, bound, and catalogued. The cost of the binding was $207.41.

These publications are made accessible to the users of the library through various indexes. The Agricultural Index, the Experiment Station Record, and the library catalog are useful tools.

It is the desire to maintain a collection which will meet the ordinary needs of the users. In connection with research, however, requests are received for special references which we do not have. This need is met by the inter-library loan service.

The Station library serves the staffs of the Experiment Station and the Agricultural Extension Service and the faculty of the College

of Agriculture. Agricultural students are given the privilege of using books from the Station collection within the reading room. The library is used by the Tennessee Valley Authority and by many workers other than those connected with the University, as well as by members of the general faculty and the student body.

The librarian attended the meeting of the American Library Association at Cincinnati, in May, and read a paper before the Agricultural section on "Aspects of Organization of a Library for the Agricultural College and Experiment Station." The paper was a picture of the agricultural library of the University of Tennessee.

CHANGES IN STAFF

NEW MEMBERS

A. H. Fitzgerald, Assistant Agronomist
Fritz Rosenthal, Plastics Technologist
Harvye Lewis, Assistant Home Economist
Mary L. Dobbs, Associate Home Economist
Paul R. Miller,, Associate Plant Pathologist[1]

RESIGNATIONS

R. A. Sutherland, Assistant Chemist
Evelyn Utley, Assistant Home Economist

DEATHS

O. W. Dynes, Associate Agronomist
H. P. Ogden, Associate Agronomist

[1]Cooperative with U. S. Department of Agriculture.

PUBLICATIONS, 1940

BULLETINS

No.	Title	Authors	Date of publication	No. of pages
171	Lespedeza Seed-Harvesting Equipment	H. A. Arnold	March	20
172	Legume Silage As a Poultry Feed	P. W. Allen, M. Jacob, N. O. Sjolander, and J. A. McBee.	September	23

CIRCULARS

66	The Columbia Spring Oats	L. R. Neel	January	2
67	Poor Germination of Mechanically Dehulled Oats	N. I. Hancock	May	4
68	Tennessee Supreme Strawberry	L. A. Fister and Brooks D. Drain	August	4
69	A Comparison of Shelled Corn, Ground Shelled Corn, and Ground Snapped Corn for Winter-Finishing Baby Beeves	M. Jacob, H. R. Duncan, L. R. Neel, and Ben P. Hazlewood	September	4
70	Tennessee Autumn Red Raspberry	Brooks D. Drain	September	4
71	The Essary Tomato	Dean M. Bailey	November	4
72	Control of Tomato Fruit Worm and Corn Ear Worm	S. Marcovitch and W. W. Stanley	December	4

ARTICLES IN SCIENTIFIC JOURNALS, 1940

Title	Authors	Place and date of publication	No. of Pages
Fluoride-Induced Reversion in Mixtures of Superphosphates and Calcined Rock Phosphate	W. H. MacIntire and L. J. Hardin	Ind. Eng. Chem. January	7
Compatibility of Fused Rock Phosphate with Superphosphate	W. H. MacIntire and L. J. Hardin	Ind. Eng. Chem. April	6
Absence of Reversion in Ammoniated and Limed Superphosphates of Low Fluorine Content	W. H. MacIntire and L. J. Hardin	Jour. Assoc. Official Agr. Chem. May	11
Thorium Nitrate Titration of Micro Quantities of Fluorine in Aqueous and Alcoholic Systems	J. W. Hammond and W. H. MacIntire	Jour. Assoc. Official Agr. Chem. May	7
Determination of Exchange Bases and Exchange Capacity of Soils	W. M. Shaw	Jour. Assoc. Official Agr. Chem. May	12
Report on Soils and Liming Materials	W. H. MacIntire,	Jour. Assoc. Official Agr. Chem. May	4
Nature and Liming Value of Quenched Calcium Silicate Slag	W. H. MacIntire, L. J. Hardin, S. H. Winterberg, and J. W. Hammons	Soil Science September	19
Availability to White Rats of Phosphorus in Soybean and Red Clover Hays	Dorothy E. Williams, Florence L. MacLeod, and Elise Morrell	Jour. Nutrition October	7
A Method of Fibre-Length Analysis Using the Fibrograph	K. L. Hertel	Textile Research October	16
Surface per Gram of Cotton Fibres as a Measure of Fibre Fineness	R. R. Sullivan and K. L. Hertel	Textile Research November	9
The Flow of Air Through Porous Media	R. R. Sullivan and K. L. Hertel	Jour. Applied Physics December	5